The Engineering News.

A Journal of Practical Science and Public Improvements.

PUBLISHED MONTHLY.

AUGUST 15th, 1875.

Survey of "Section 6."

In the subdivision of a Township into sections, the survey commences with the south-east and terminates with the north-west section, and it is in this latter, or "Section 6," that the most complex problems that can arise in our very simple system of public surveys are to be found. We think it may be conceded, that if surveyors can agree upon a uniform method of subdividing this particular section, they will find no difficulty in any other in the township, except in extraordinary cases.

According to the Instructions, *random* lines are run west and north from the south-east corner of the section, to the lines forming the west and north boundaries of the township, setting on each line temporary quarter corners at 40 chains, and after noting the "falling" at the established corners on the Township lines, return on *true* east and south lines, setting quarter corners on true line, and *exactly* 40 chains from the south-east corner of the section. But in "Townships lying *south* of, and *contiguous* to the base, or to any standard parallel, the lines between the northern tier of sections will be run *north*, and be made to close as *true* lines; quarter section corners will be set at 40 chains, and section corners established at the intersection of such section lines with the base or standard (as the case may be) and the distance is to be measured and entered in the field book to the nearest corner on such standard or base.' From these instructions it would appear that "jogs" at the township lines can only occur at the standard parallels or base lines, when, in reality, (in this county at least) there is scarcely a township line without from one to six on it.

The north and west line of Section 6, having been run previously in the survey of the township, the lengths are known, and the section as shown by the Government record is platted therefrom.

In the accompanying figures we present four methods of subdividing the Section. Fig. 1 is in accordance with the instructions, except that there are jogs at the N. E. and S. W. corners, the difference between the lengths in the two sides of the line showing the distance between the corners.

Fig. 1.

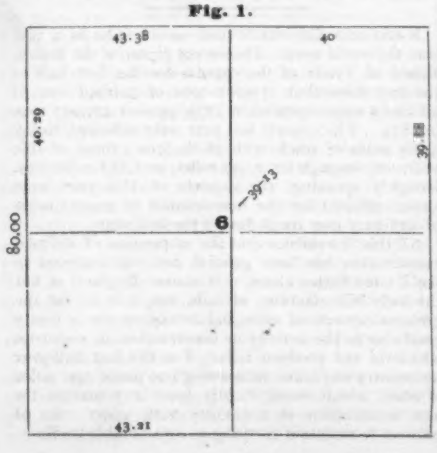
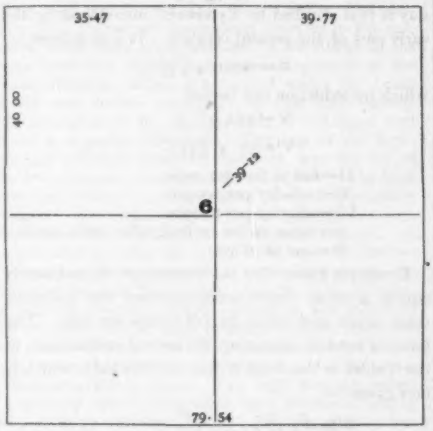
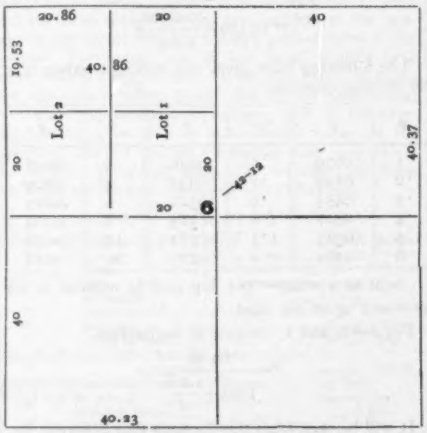


Fig. 2.



In Fig. 2 the whole length of the south line of the section is given, and the quarter corner on the north line is placed at *one-half* this distance from the N.E. corner of the section. In this case there is a jog of 3.50 chains at the N. E, corner, and a mistake was made in the recorded length of the west half of the line, and we propose to bring this case before our readers in a future number, so as to obtain some opinions respecting it.

Fig. 3.



In Fig. 3 the N. W. ¼ is divided into lots and figured according to the Instruction on page 25 of the Manual, which says that "interior lots in such extreme tiers are to be *twenty* chains wide, and the excess or deficiency of measurement is always to be thrown on the exterior lots; elsewhere the assumed subdivisional corner will always be a point equidistant from the established corners," which latter clause constitutes the fourth method shown above in Fig. 3, the length of the west half of the line being expressed by the one dimension 40-86 chains.

Now as to the subdivision of the N. W. ¼ of Section 6; in all the above cases we will suppose that the four corners of the quarter section are established; we know of no other method, in Figs. 1 and 2, but to set the eighth corners equidistant between the established corners; in Fig. 3, first case, we would divide the actual distances *pro rata* between the recorded distances, and set eighth corners accordingly; in the second case we would divide equi-distant, as in Figs. 1 and 2, and if we were called on to survey the N. W. ¼ of the N. W. ¼, under the case supposed by T. H., in our May number, we would follow the same method of equal division. As we have stated in a previous article, there is no such thing as measuring off an even *twenty*, or other number, of chains, and setting a corner. The very first thing that the Deputy Surveyor is required to do when commencing the subdivision of a township, is to *compare* his chain, and his compass variation, with that of the previous survey of the township boundaries, and having determined the necessary corrections, he may proceed with his survey. There ought not to be differences between surveys where *pro rata* measurements between the same points are adopted; in ordinary surveying there can seldom be anything but differences where any other system is followed. One of the principal features of the rectangular system of surveys is its simplicity; by unfaithful and careless work, errors in measurements and location of corners, have been fastened on it; but we believe that in the adoption of a few—a very few—simple rules of practice, every problem would be found extremely easy of solution, and the chances for disagreement of surveyors, and its consequent litigation would very speedily be reduced to a minimum. We give a few such rules.

1st. Follow closely the original survey, where any evidence of it can be found.

2nd. Adhere strictly to *pro rata* [which will include also equidistant] measurements.

3rd. Find the centre of the section by means of the intersection of straight lines run from quarter corners to opposite corresponding quarter corners, and follow the same method down to the smallest division of the section.

4th. Do not be finical, but if the Government has marked out a line on the ground, and called it "due north," accept it as such, even if run "due northwest."

5th. In the subdivision of fractional sections run intermediate corners between existing lines.

If by any other rules of practice a greater degree of accuracy in subdividing sections can be obtained, than by the above, the profession should know them, and we hope they will be forthcoming.

We reprint this month from the Proceedings of the Institution of Civil Engineers, the first part of an exceedingly interesting and valuable paper on the "Consolidation of Earthworks," by an eminent French engineer, and in the two succeeding issues of our journal will give the whole paper.

This article alone is well worth to every railroad engineer many times the price of our paper, and we trust that our readers will call the attention of their engineering friends to the fact that we are publishing such valuable information, and that ours is the only journal on this continent that meets the wants of the great body of the profession, and that we will spare no effort in the future to improve on what we have already done. We desire just here to call attention to our supplementary sheet of drawings illustrative of the foregoing article. The drawings were copied from the woodcuts, and recopied with authographic ink on prepared paper, and a transfer to stone taken directly therefrom. We can, during these dull times prepare similar drawings for parties who may want cheap and effective illustrations of subdivisions, machinery, or maps.

The Engineering News.

A Journal of Practical Science and Public Improvements.

PUBLISHED MONTHLY.

AUGUST 15th, 1875.

Survey of "Section 6."

In the subdivision of a Township into sections, the survey commences with the south-east and terminates with the north-west section, and it is in this latter, or "Section 6," that the most complex problems that can arise in our very simple system of public surveys are to be found. We think it may be conceded, that if surveyors can agree upon a uniform method of subdividing this particular section, they will find no difficulty in any other in the township, except in extraordinary cases.

According to the Instructions, *random* lines are run west and north from the south-east corner of the section, to the lines forming the west and north boundaries of the township, setting on each line temporary quarter corners at 40 chains, and after noting the "falling" at the established corners on the Township lines, return on *true* east and south lines, setting quarter corners on true line, and *exactly* 40 chains from the south-east corner of the section. But in "Townships lying *south* of, and *contiguous* to the base, or to any standard parallel, the lines between the northern tier of sections will be run *north*, and be made to close as *true* lines; quarter section corners will be set at 40 chains, and section corners established at the intersection of such section lines with the base or standard (as the case may be) and the distance is to be measured and entered in the field book to the nearest corner on such standard or base.' From these instructions it would appear that "jogs" at the township lines can only occur at the standard parallels or base lines, when, in reality, (in this county at least) there is scarcely a township line without from one to six on it.

The north and west line of Section 6, having been run previously in the survey of the township, the lengths are known, and the section as shown by the Government record is platted therefrom.

In the accompanying figures we present four methods of subdividing the Section. Fig. 1 is in accordance with the instructions, except that there are jogs at the N. E. and S. W. corners, the difference between the lengths in the two sides of the line showing the distance between the corners.

Fig. 1.

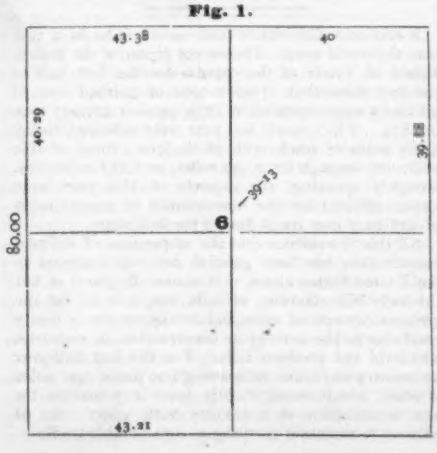
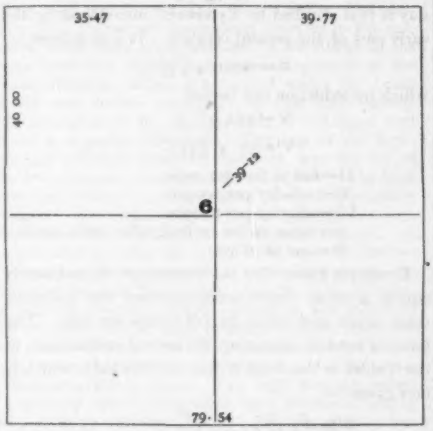
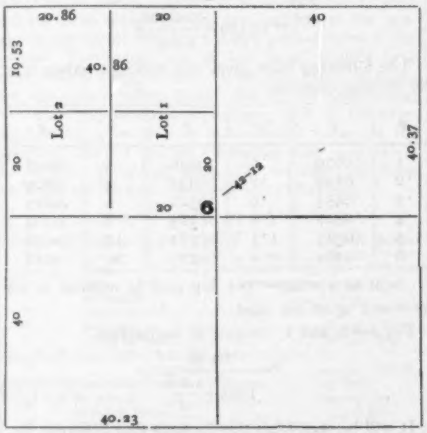


Fig. 2.



In Fig. 2 the whole length of the south line of the section is given, and the quarter corner on the north line is placed at *one-half* this distance from the N.E. corner of the section. In this case there is a jog of 3.50 chains at the N. E, corner, and a mistake was made in the recorded length of the west half of the line, and we propose to bring this case before our readers in a future number, so as to obtain some opinions respecting it.

Fig. 3.



In Fig. 3 the N. W. ¼ is divided into lots and figured according to the Instruction on page 25 of the Manual, which says that "interior lots in such extreme tiers are to be *twenty* chains wide, and the excess or deficiency of measurement is always to be thrown on the exterior lots; elsewhere the assumed subdivisional corner will always be a point equidistant from the established corners," which latter clause constitutes the fourth method shown above in Fig. 3, the length of the west half of the line being expressed by the one dimension 40-86 chains.

Now as to the subdivision of the N. W. ¼ of Section 6; in all the above cases we will suppose that the four corners of the quarter section are established; we know of no other method, in Figs. 1 and 2, but to set the eighth corners equidistant between the established corners; in Fig. 3, first case, we would divide the actual distances *pro rata* between the recorded distances, and set eighth corners accordingly; in the second case we would divide equi-distant, as in Figs. 1 and 2, and if we were called on to survey the N. W. ¼ of the N. W. ¼, under the case supposed by T. H., in our May number, we would follow the same method of equal division. As we have stated in a previous article, there is no such thing as measuring off an even *twenty*, or other number, of chains, and setting a corner. The very first thing that the Deputy Surveyor is required to do when commencing the subdivision of a township, is to *compare* his chain, and his compass variation, with that of the previous survey of the township boundaries, and having determined the necessary corrections, he may proceed with his survey. There ought not to be differences between surveys where *pro rata* measurements between the same points are adopted; in ordinary surveying there can seldom be anything but differences where any other system is followed. One of the principal features of the rectangular system of surveys is its simplicity; by unfaithful and careless work, errors in measurements and location of corners, have been fastened on it; but we believe that in the adoption of a few—a very few—simple rules of practice, every problem would be found extremely easy of solution, and the chances for disagreement of surveyors, and its consequent litigation would very speedily be reduced to a minimum. We give a few such rules.

1st. Follow closely the original survey, where any evidence of it can be found.

2nd. Adhere strictly to *pro rata* [which will include also equidistant] measurements.

3rd. Find the centre of the section by means of the intersection of straight lines run from quarter corners to opposite corresponding quarter corners, and follow the same method down to the smallest division of the section.

4th. Do not be finical, but if the Government has marked out a line on the ground, and called it "due north," accept it as such, even if run "due northwest."

5th. In the subdivision of fractional sections run intermediate corners between existing lines.

If by any other rules of practice a greater degree of accuracy in subdividing sections can be obtained, than by the above, the profession should know them, and we hope they will be forthcoming.

We reprint this month from the Proceedings of the Institution of Civil Engineers, the first part of an exceedingly interesting and valuable paper on the "Consolidation of Earthworks," by an eminent French engineer, and in the two succeeding issues of our journal will give the whole paper.

This article alone is well worth to every railroad engineer many times the price of our paper, and we trust that our readers will call the attention of their engineering friends to the fact that we are publishing such valuable information, and that ours is the only journal on this continent that meets the wants of the great body of the profession, and that we will spare no effort in the future to improve on what we have already done. We desire just here to call attention to our supplementary sheet of drawings illustrative of the foregoing article. The drawings were copied from the woodcuts, and recopied with authographic ink on prepared paper, and a transfer to stone taken directly therefrom. We can, during these dull times prepare similar drawings for parties who may want cheap and effective illustrations of subdivisions, machinery, or maps.

FIG.1

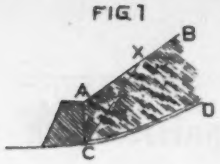


FIG.2

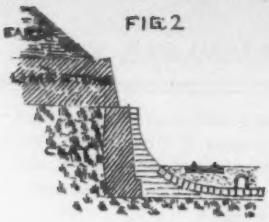


FIG.3

FIG.4

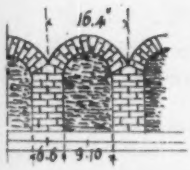


FIG.9

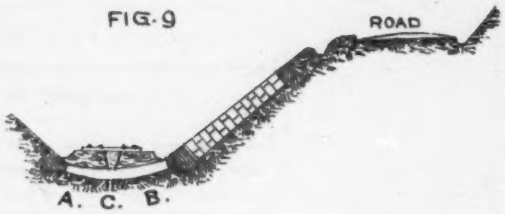


FIG.10

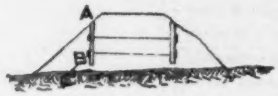


FIG.11

FIG.15

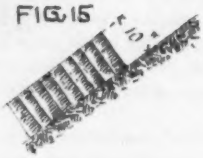


FIG.16

FIG.17

ILLUSTRA D

FIG.20

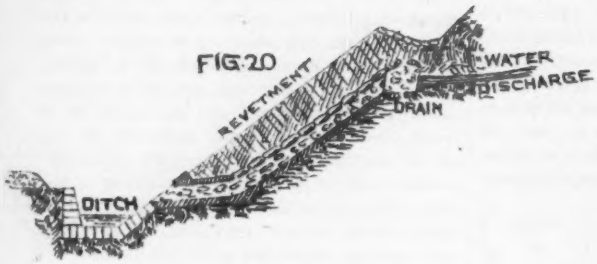


FIG.21

FIG.22

CONSOLIDATI F E

FIG.25

FIG.26

FIG.30

FIG.31

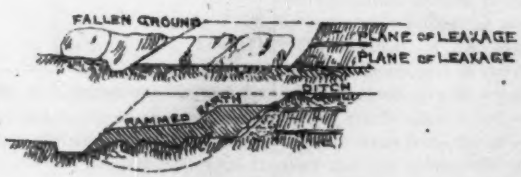


FIG.35

FIG.36

FIG.40

FIG.41

FIG.5

FIG.6

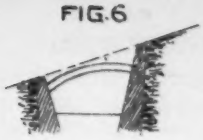


FIG.7

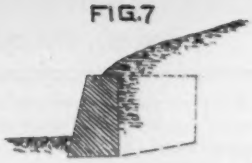


FIG.8

FIG.12

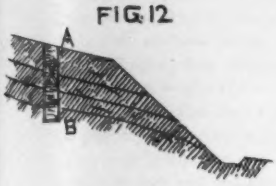


FIG.13

FIG.14

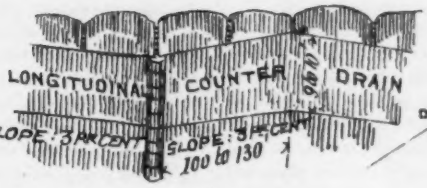


FIG.18

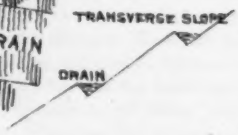


FIG.19

D SHEET

F EARTHWORKS.

FIG.23

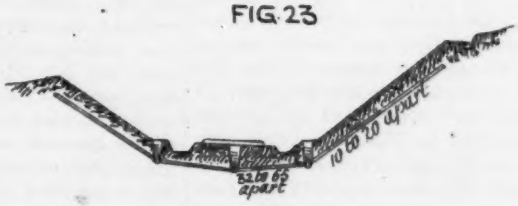


FIG.24

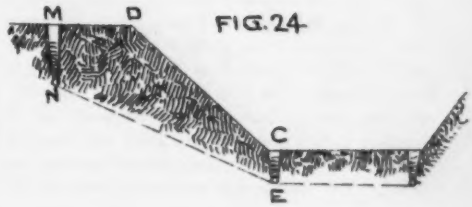


FIG.28

FIG.29

32

FIG.33

FIG.34

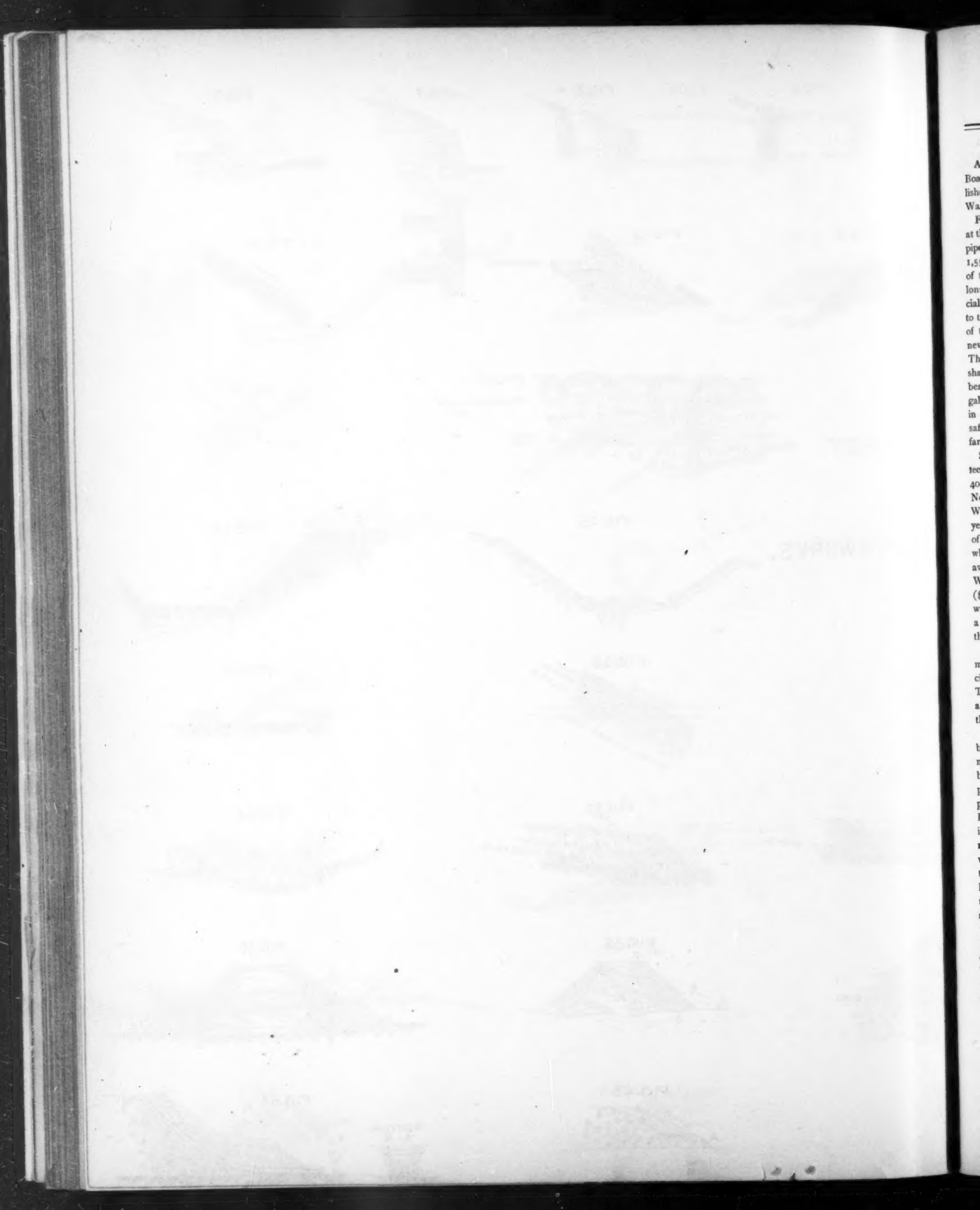
FIG.38

FIG.39

FIG

FIG.43

FIG.44



OUR PUBLIC WORKS.

Advance sheets of the 14th Annual Report of the Board of Public Works of this city, have been published. The principal items of interest refer to the Water Supply, Sewerage, Streets, and Public Parks.

From the report of the Board, it now appears that at the time of the 1871 fire we had 272 miles of water pipe; now we have nearly 400, There were then 1,552 hydrants; now there are 2,607. The capacity of the Water Works at that time was 38,000,000 gallons per day; before the close of the present financial year, it will be 100,000,000 gallons! In addition to this total increase in the quantity of water, many of the old pipes and hydrants have been replaced by new ones, and ten large fire-cisterns have been built The Report states that as soon as the new engines shall be in working order (two compound, condensing, beam-pumping engines, capable of raising 30,000,000 gallons 155 feet high in twenty-four hours), namely, in November of this year, Chicago will be one of the safest cities in this country—if not in the world—so far as the water supply is concerned."

Since the year 1871, there have been laid 521,387 feet of water-pipe, — or 100 miles, — at a cost of $1,409,453, also 353 hydrants, of which 66 were in the North Division, 129 in the South, and 158 in the West. The income from water-collections for the year (which ended in April) was $705,926, a decrease of $2.877 on the collections of the previous year, which was occasioned by the July fire, that swept away 560 acres of buildings. The total income of the Water-Works since 1854, has been six millions ($6,086,616). The expenditures connected with the water supply for the past year were $617,065, leaving a surplus for the year of 88,861, which goes to show that the water-works are more than self-supporting.

In regard to the waste of water, the Board recommend the general use of meters, whenever the financial condition of the city will allow of their purchase. The comments of the Board upon the waste of water are very forcible and pertinent, and ought to commend themselves to water-users throughout the city.

During the year, 42 miles of sewerage have been built, making the entire sewerage of the city 240 miles, the whole cost of construction for the year being $587,507. Eight miles of streets have been paved during the year, making a total of 111 miles of paved streets in the city. In this connection, the Board very curtly hints that many of the streets are in a very bad condition, and that "There can be no radical or permanent improvement until the tax-payers with whom the matter is optional, choose to pave them." During the year, over 72 miles of sidewalks have been laid, making 725 miles in the city. During the year, 712 building-permits were issued, and 244 applications for the removal of wooden buildings were favorably acted upon. In connection with this branch of their report, the Board very strongly condemn the practice of allowing the removal of wooden buildings within the city limits, and their protest ought to be recognized. There is great good sense in their statement that "The fire-ordinance now prohibits a citizen from erecting a wooden building, and, on the theory of general protection, requires him to use brick or stone. It is a serious violation of this theory and a gross injustice to citizens thus prohibited, to authorize the removal of old wooden buildings into proximity with structures built in accordance with the provision of the ordinance."

Among the miscellaneous improvements accomplished during the year are the following: Dredging in the river has been carried on at a total expenditure of $49,710.38. New bridges have been built over the Ogden Canal, at Randolph street, at Fullerton ave., and a viaduct over the track at North Halsted street. Five engine-houses and an engine-house and police-station have also been built. There have been expended upon the nine parks belonging to the city, which embrace about 75 acres, $40,051.54.

Astronomical Notes.—No. VI.

PREPARED FOR THE ENGINEERING NEWS BY S. W. BURNHAM, F. R. A. S.

In the *Astronomische Nachrichten*, No. 2045, Baron Dembowski has a very interesting communication concerning one of the most remarkable systems of stars known in the heavens. Some time last year he published a list of nine new double stars, one of which was a pair of 6.5 and 8.0 magnitude stars, with a separating distance of 8".26, and position angle of 120°.5. A short time subsequently, the writer after having observed the pair with a telescope, called his attention to the undoubted identity in place of this with No. 503 of Sir James South's Catalogue, and the further fact that a great change must have occurred since South's observation in 1825, as he made the distance 39".94, and the angle 134°.1. No other early measures could be found, nor any since up to Dembowski's first observation in 1873, but South's results are fully confirmed by a reference to Weisse's Catalogue of stars, (Nos. 1206 and 1207.) where fortunately both components are given. The angle and distance computed from the meridian observations made about the same time, are respectively 42°.2 and 136°.6, showing that no mistaken entry was made by South. The measures of Dembowski made between the latter part of 1873 and the last of March of the present year show, even in this short period, a decided decrease in both angle and distance.

It should be mentioned also that there is a third and more distant star which has changed considerably with reference to the other two during the interval. South gave: D=201°.76; P=337°.3, and the corresponding results from Weisse's catalogue (No. 1202), are 197°.0 and 337°.9. The distance now, according to Dembowski is 230".16, and the position angle, 335°.8 Whether this large movement is due to proper or orbital motion remains to be learned by future observation; but that it is a wonderful system of some kind there can be no doubt. It will probably receive the careful attention of astronomers, and the true nature of a change, almost without a parallel, fully investigated. The place of the principal star is R. A. 5h. 52m.; Decl. N. 13°56'.

M. Andre has communicated to the French Academy of Sciences the result of a comparison of the observations of the transit of Venus at New Caledonia and St. Paul's Island. The results obtained from one of the telescopes at the first station compared with those at St. Paul's agree well with the received value of the solar parallax 8".86, but the other two telescopes give results differing much from this, and are therefore suppressed. The two stations are not favorably placed for comparison of durations, and the results seem to have been worked out only with a view of getting something tangible out of the observations, and cannot be expected to decide the delicate question involved. The reduction of the English observations is proceeding vigorously, and all instrumental errors that could affect the result are being carefully determined, but many months must elapse before any final value of the sun's parallax can be obtained, even if the English observations were used only, and it will probably be some years before the data collected by all nations are combined into one grand result.

Prof. Joseph Winlock, Director of the Cambridge Observatory, died suddenly on the morning of June 11th, at the age of forty-nine. Prof. Winlock has been for many years identified with astronomical and scientific institutions, and always highly esteemed for his valuable researches. In 1845, after graduating from Shelby College, he was appointed Professor of Mathematics and Astronomy in that college, where he remained until 1852,. when he removed to Cambridge and was engaged on the "American Ephemeris and Nautical Almanac," then under the superintendence of Admiral Davis. In 1857 he was appointed Professor of Mathematics in the U. S. Navy, and in that capacity served as Assistant, at the Naval Observatory at Washington, as superintendent of the "Nautical Almanac." and as Director of the mathematical department of the Naval Academy at Annapolis. On the breaking out of the war in 1861, he was a second time made Superintendent of the "Nautical Almanac." In 1865 he was made Director of the Observatory of Harvard College, after the death of Prof. Bond, and has since been in charge of the important astronomical work of that institution. His successor has not yet been named.

A new edition of Chamber's "Descriptive Astronomy" is in press and will soon be published in London. This has been regarded as one of the most valuable works of the kind hitherto prepared. The second edition was very copiously illustrated with excellent engravings of the principal objects of interest in the solar and sidereal systems, and of the different instruments and appliances used in practical astronomy. A large amount of tabular information has made it particularly useful as a work of reference to those not having at hand extensive astronomical libraries. For instance, the lists of the principal comets, red stars, asteroids, variable stars, double stars, etc., are sufficiently complete to supply the demands of amateur observers, and in many respects professional astronomers. As Mr. Chambers some months since issued a card requesting corrections of any errors which might have been noticed in the former edition, it will doubtless in this and other respects be made even more valuable than before.

Dr. Doberck has computed the period of the binary star γ Leonis, and finds the time to be 402·62 years. Comparing Struve's measures in 1821 with Dembowski's in 1870, we find a retrograde motion of but 7°.3, with an increase in the distance of about 0.6" No very thorough discussion of the observations has been had previously with which to compare the results now found, but it is probably only an appproximation, as the change is but slight during the time it has been carefully observed.

Dr. Doberck also finds the periodic time of τ Ophiuchi to be 217.87 years, differing materially from Hind, who placed it at 120 years. Since the

early observations the distance has considerably increased, and it is now within the reach of moderate telescopes. Between 1836 and 1871 the angle of the components has advanced 47°.6. This pair has been regularly measured by the most expert of the double star observers, Baron Dembowski, and his results are of the greatest value in the series.

A new observatory is soon to be erected by the Austrian government, near Trieste, and is to be supplied with the latest and most improved instruments and accessories. Messrs. Alvan Clark and Sons have received an order for the construction of a first-class equatorial.

PERSONAL.

Mr. H. A. Gardner, Chief Engineer of the Michigan Central Railroad, died in Chicago, July 26, after a protracted illness. Mr. Gardner was a native of South Lee, Mass., and had been connected with railroads for many years. He was associated with the now venerable Col. R. P. Morgan (his father-in-law) in making the surveys for the Hudson River road, and afterwards succeeded Mr. John B. Jervis as Engineer in charge of its construction. He was subsequently for several years Chief Engineer of the Pittsburgh, Fort Wayne & Chicago. As an engineer, Mr. Gardner had a high reputation, which he well earned by his judgment, integrity and wide experience. He had been a member of the American Society of Civil Engineers almost from its foundation.

PUBLICATIONS RECEIVED.

ABSTRACT of Papers in Foreign Transactions and Periodicals. Published by the Institution of Civil Engineers, London. 1875.

"CARE OF THE SICK," and "ACCIDENTS, EMERGENCIES AND POISONS." Two very excellent publications, handsomely illustrated. Sent free to any applicant, by the Mutual Life Insurance Company of New York.

COLSON ON THE PORTLAND CEMENT used in the Portsmouth Dockyard Extension Works. Institution of Civil Engineers. London. 1875.

REPORTS OF WATER BOARDS of the Cities of Lynn, New Bedford, and Fall River, Mass.

TRANSACTIONS of American Society of Civil Engineers, June, 1875.

REPORT of the City Engineer of Grand Rapids, Mich, for the year ending May 1, 1875.

Trigonometrical Surveying.

In carrying on a survey, the distance (W E) of the stations W and E, and also of the situation of the object O, become necessary. Now A, B, and C, were three known objects, the distance being AC—4,060, AB—3,200, and CB—1,800 yards; but at the station W, the object C conld not be seen, and an intervening height hid the object A at the other end of the station E. I therefore set up marks at W and E and took the following horizontal angles:

At W { AWB—96° 10′ ; BWE—48° 30′ ; OWE—58° 44′ }

At E { BEC—50° 4′ ; BEW—70° 56′ ; WEO—32° 50′ }

From these data I want to find WE, EO, and WO.

B. McG., Liverpool, Eng.

CORRESPONDENCE.

IOWA STATE UNIVERSITY.
Chair of Civil Engineering.

IOWA CITY, June 5, 1875.

EDITOR ENGINEERING NEWS.

Dear Sir:—I cannot afford to be without the NEWS. It fills the place for which it was designed admirably, Truly yours,

P. H. PHILBRICK,
Professor.

HAVERSTRAW, N. Y.

GEO. H. FROST, Esq.,

Dear Sir:—Can you refer me to some work or explain through the NEWS a speedy method of taking right the *contour* or topography of very hilly ground by means of an instrument which measures horizontal and vertical angles.

Your very truly; L. W.

ANS.—See article on Topographical Surveying, &c., in present No. of ENGINEERING NEWS. We think also that Messrs. Wm. J. Young & Sons, the celebrated mathematical instrument makers of Philadelphia, can help you with instruments and instruction that will enable you to make the desired surveys quickly, correctly, and economically. ED.

LINDSAY, ONT., June 16, 1875.

EDITOR ENGINEERING NEWS.

Dear Sir:—I received the five numbers for 1875 of your valuable and interesting paper and regret that I was not aware of its existence before; but in order to make amends for my ignorance and to help in a small way a paper which I think should be supported by every person connected with Engineering or Surveying on the continent of America, I send you as a first installment four names of subscribers and four dollars.

Wishing you every success in your enterprise,
I remain yours truly, J. R.

PHILADELPHIA, July 19th, 1875.

FRIEND FROST.

We thought your paper had almost an exclusive western circulation, but we have lately had calls for our pamphlet from parties who have seen our advertisement in your paper, from Canada (five in one week) and from the extreme eastern States, Maine, New Hampshire, Vermont, &c.—do you circulate up there, or are there only copies sent by Engineering friends? We are afraid you must wait for those articles on "Stadia Measurements, &c.," until the nights get longer, as we are too much occupied at present to think of anything else than of getting our work off our hands. Bye-the-bye, we have read with much interest the various articles from your correspondents on Stadia measurements, but some of them show a want of optical knowledge in their premises. If you were to take from our pamphlet, page 16 and 17, the article on "Stadia measurements" bodily, and reprint it, we think you would give these inquirers the whole facts in the case—the formula at the bottom of page 17 being *especially valuable*, as showing where the monuments start from.

The page of "Topographical conventional signs," that is in the frontispiece of the book, fills a want of long standing both in this country and in Europe, and the table of "errata and additions to Trautwine's Engineers' pocket book" (to be found at the end), are especially valuable, and if you will call the attention of Civil Engineers to the fact that we will forward these five pages of "errata" to any address, to any one sending a three-cent stamp for postage, we think many will avail themselves of the opportunity.

Yours, &c.,
HELLER & BRIGHTLY.

NEW BEDFORD, MASS., July 26, 1875

GEO. H. FROST, Esq.

Dear Sir:—Your ENGINEERING NEWS, good at first, has grown to be more and more valuable. I intended to have written something occasionally for print but have failed to do so.

A Cornish engine, 100-inch cylinder, 11 ft. stroke is now being set up for the Providence Water Works at the Pettaconsett Pumping Station. Also at the Hope Station, in the city, a compound Steeple engine with horizontal pumps is being erected; the speed of the engine as compared with the speed of the pumps is as 5 to 1, the speed being reduced by gearing. When these machines are completed, the Providence Water Works will have four different kinds of pumping engines: a Worthington, a Corliss, a Cornish, and a Steeple. The Corliss pumping engine is unlike anything in the world, and would furnish you a good subject for an article sometime. Mr. Corliss, at his works, has a large pumping engine of his own. He is also building the third one. I understand that he is building a pair of large Beam engines (similar to those in the Wamsutta Mills, here), for the running of the machinery at the Centennial at Philadelphia.

The Fall River Water Works are having a five-million Worthington engine put in at their pumping station. Mr. Worthington has lately made some improvements in his engine.

I have been interested in hearing about the pair of compound engines that are building for your Water Works at the termination of the new tunnel. They are building at the Quintard Iron Works, N. Y., and I intend to see them before they are shipped. I must close by wishing success to the ENGINEERING NEWS.

Respectfully, G. B. W.

SHAWANO, Wis., June 7th, 1875.

DEAR SIR:

How should a lost quarter corner be restored in cases where the Government *blazed line* is very distinct—equidistant between known section corners upon the *blazed* line, or upon a *straight* line? In some cases the blazed line at the quarter corner is from 20 to 200 links from a straight line.

As there is a diversity of opinion on this point, you will confer a favor by giving us your opinion in the ENGINEERING NEWS. Yours truly, J. M.

ANS.—We should follow as closely as possible the "blazed" line of the Government survey; if the "running notes" could be had so much the better. We cannot see where any private surveyor can find authority for leaving the line of survey as *marked on the ground.*

SANTA FE, New Mexico, July 28.

A paper read before the C. E. Club of the North-West was published not long ago, upon the United States Mining laws and regulations thereunder. I forget the name of the lecturer, and have mislaid the paper, but I remember, among other things, he stated that mineral deputy surveyors were required to *give bond* and that all mining surveys executed by them had to be *connected* with the public surveys "when within six miles" of these. As I find neither of these requirements in the law and regulations, allow me to inquire of the editor of the NEWS, or of the the learned lecturer, or of any one informed in the premises, where these requisites, or either of them may be found. Whoever shall impart the information will place under obligation at least one

SUBSCRIBER.

ROCHESTER, Minn., Aug. 4, 1875.

MR. EDITOR:—In the abridgement of my communication appearing in the May number of the NEWS, page 58, you omitted an important part of my question, for its correct solution.

By placing the letter A at the N. E. corner of the diagram of the section there given, E at the S. W. corner, F at the quarter post on S. side, and H at the ¼ post on E. side, and making the distance AH —39.80 and EF—39.60, he problem will then be complete, and as originally given.

J. B. was right when he said the question was incomplete and could not be legally solved in chains and links except on the section lines BC and CD. I would call J. B.'s attention to his communication in the July number of the NEWS, page 93, and ask him if there is not some typographical errors in it as published? and if he understood the diagram accompanying my question to be the diagram of a section,

and BCDK to be the N. W. ¼ of said section? And if he answers in the affirmative, I would respectfully ask him to point out or locate those nine quarter corners which he found on one quarter section! He could not have found them in my communication, as I did not once mention quarter corner or refer to one by name,, my questions having reference entirely to quarter quarter or 1-16 section corners of which there can be *five* on a ¼ section, the same number as there can be ¼ corners to a section; and the 1-16 section corners bear precisely the same relation to a quarter section that the ¼ posts do to a section.

In the field, I always mark my quarter quarter corners "1-16 S" all of them, and if J. B. or any one else can give any good, or even plausible reasons for marking some of them 1-16 S. and others ⅛ S., as he claims the should be, I would like to hear them—or for marking *any* of them ⅛ S. True, in common parlance we may call them eighth corners or eighth lines, the same as we sometimes call the quarter posts half section corners; but who ever saw one of these corners marked ½ S.? or would contend for thus marking them. Yet there is as much propriety in marking them thus, as there is in marking the quarter quarter corners ⅛ S.

Let us have uniformity if possible, Mr. Editor, in marking our corners if in nothing else. T. H.

MR. EDITOR:

On the 93rd page of the July NEWS, E. O. gives a diagram of a portion of the line between Ohio and Michigan, where he claims the lines overlap, and asks how the ¼ posts should be set, whether on a right line between its own proper section corners, or on the zigzag line formed by the overlap as he calls it.

Now I will venture to say that the official plats show but a single line as having been run and marked, and that the corners for the sections lying both north and south of this line, are held to be on this line. The double corners show that one set were closing corners; and the very idea of a closing corner pre-supposes a line, to close upon, already run. If thus there is but a single line recognized by the land department, that line is marked by all the corners set, or supposed to be set on it, however crooked a line it may form, and in the case given the line should run from A to B and B to C and from C to D.

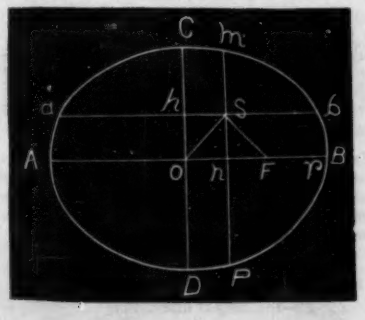
The variation of B from a straight line A C (only 8 links), is fully as near as the majority of ¼ posts stand to a right line between the adjacent section corners, on interior sections. T. H.

Practical Mathematics.

The water in a canal lock rises to a height of 18 feet against a gate whose breadth is 11 feet; calculate the total pressure against it.

A dyke to shut out the sea is 200 yards long, and is built in courses of masonry of one foot high; the water rises against it to a height of 6 fathoms; calculate the pressure against the 1st, 18th, and 36th courses.

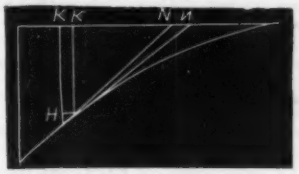
MR. EDITOR.—The first requirement of the problem of the elliptical garden, in the April number, is that the seat should be placed at some point s, an equal distance from the center o, focus F, and side m, as shown in the figure Now it is evident



this point will be situated somewhere on the line n m, perpendicular at the centre of the line O F. It is customary in Analy'l Geo'y to represent half the major axis A O by A, and half the minor axis by B. We will take the given quantities all in feet: A O—A—75, C O —B—60, O F—$(A^2-B^2)^{\frac{1}{2}}$—45. The equation of the ellipse referred to its centre for the origin of co-ordinates is (Robinson's An. Geom.) $A^2y^2+B^2x^2=A^2B^2$. In this equation take x—O n—22½; then y—n m—57.23. To locate the seat we take O s—S F—S m—x, then by Euclid $(O s^2-O n^2)^{\frac{1}{2}}$—n s, but n s+s m —n m, therefore $\sqrt{x^2-(22\frac{1}{2})^2}+x=57.23$, from which we have the value of x—33.04. Now m s—33.04 and s p—81.42. To calculate the distance s b, s a. we have b r—s n—y—24.19; this value of y, put in the equation of the ellipse gives the value of x—o r—h b—68.63. but h b—h s—s b—43.13, s h+h a —s a—91.13. To find where the middle of the walk crosses the lines s m, s a, s p, s b, we observe that the gentleman's eye, when seated, is four feet above the plane of the garden, the top of the gardener's head is two feet above the gentleman's eye, and the top of the wall is 19 feet above the same point. By similar triangles we have 19 : m s—(33.04) : : 2 : 3.48; 19 : s a—(91.13) : : 2 : 9.59; 19 : s p—(81.42) : : 2 : 8.57; 19 : s b—(43.13) : : 2 : 4.54. Any number of points can be located around the point s by the polar equation of the ellipse (Robinson's An. Geom., page 163), but enough has been found to show that the requirements of the problem place the *center of the walk too near the seat* s, to be made of *equal width* and occupy 1-20 of the garden. This part of the problem being absurd we pursue it no farther.

PROBLEM OF THE FOX AND DOG.

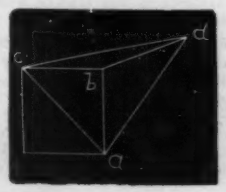
There are several methods of solving this problem. I shall take the one I consider the most practical.



The fox is supposed to be at F, and runs on the line F O, the dog at S and runs on the curve S D O. Let D represent the position of the dog when the fox is at N, on the tangent to the curve at D, draw D K parallel to S F, and d k *infinitely near* and parallel to D K, draw D N tangent to the curve at D, and d n tangent to the point d, and draw N I perpendicular to d n, and d H perpendicular to DK. Put S F —a—60, F K—w, F N—x, D N—y, and curve S D —z. Then is K k—d w, N n—d x, I n—D d—d y, and D d—d z; and by the similar triangles H D d and I N n we have d z : d w : : d x : I n; but by the problem d x—4-5 d z therefore d z : d w : : 4-5 d z : I n—4-5 d w; d y—I n—D d—4-5 d w—d z but we have d z—5-4 d x substitute and d y—4-5 d w. Whence by integrating x—16-25 w—4-5 y+C (1). To determine the constant C, we observe that when w —o in (1) then x—o and y—a therefore C—4-5 a. Put this value in (1) and x—16-25 w—4-5 y+4-5 a. Now when the dog overtakes the fox in running on the curve, the point s D and N, will coincide and consequently y will become zero, and w will become x, and we have x—16-25 x+4-5 a; therefore 9-25 x—4-5 a, or x—20-9 a. By the question z—5-4 x—100-45 a—133⅓ rods run by the dog to catch the fox.

POINT AND SQUARE.

We have given in this problem c d—40, b d—20, a d—30. Take the ∠ c d b—x, ∠ b d a—y, then the ∠ c d a—x+y, side of square c b—b a—s. By Euclid c a—$\sqrt{2}$ s.



We have by trigonometry $a^2=b^2+c^2-2\,b\,c\,\cos.A$; applying this equation to the triangle c d b, we have s^2—2000—1600 cos. x, (1). Triangle b d a gives s^2—1300—1200 cos. y, (2). Triangle c d a gives s^2—1250 —1200 cos. (x+y) (3). Equating (1) and (2), (2) and (3) and reducing, we then have

$$\cos. x-\tfrac{3}{4}\cos. y=7\text{-}16 \qquad (4)$$

$$\cos. y-\cos.(x+y)=1\text{-}24 \qquad (5)$$

In equation (4) if we take the arc x equal to zero, then cos. x—1, and cos. y—¾; these values substituted in (1) and (2) reduce them to s^2—400, s^2—400 or s—20; but the arc x—0 in (5,) gives the manifest absurdity cos. y—cos. y—1-24. Again, since the ∠c b d is taken equal to zero, the line c d must coincide with c b, and c b d will be a straight line and thus satisfies one branch of the problem perfectly. But since a b—b d—20, the triangle a b d is isosceles and because an arc whose cosine is ¾ is *less* than 45° the angle a b d is *greater* than a right angle and consequently the angle a b c is *less* than a right angle. Therefore the given numbers do not satisfy the conditions of the problem and are shown by our investigation to be absurd.

COLUMN AND STATUE.

We take it for granted that the column B D and statue D E stand perpendicular on the plane A B.

Take the ∠ B A E—a, ∠ B A D—B, ∠ BAC—y, and AB —x, the breadth of the river. We have given B C—6, B D—200, and B E—230. By trigonometry we have tan a—$\frac{230}{x}$, tan. B—$\frac{200}{x}$, tan. y—$\frac{6}{x}$. By the problem the ∠ DAE—∠ B A C; that is y—a—B, and by trigonometry

tan. y—$\frac{\text{tan. a—tan. B}}{1+\text{tan. a tan. B}}$; substitute the values obtained above and we have the equation

$$\frac{6}{x}=\frac{\frac{230}{x}-\frac{200}{x}}{1+\frac{230}{x}\times\frac{200}{x}},$$

reduce, and we have x^2—11500 or x—107.238 + feet the breadth of the river.

J. N., C. E. and Surveyor,
Mansfield, Ohio.

DUBUQUE, July 30, 1875.

EDITOR ENGINEERING NEWS.

Sir:—I take the liberty of sending you a solution as I think it, of the problem in your last number of the excellent NEWS, relating to the "Fox and Dog." It is readily shown that the dog must run on an elliptic course, for at every point of his course he is supposed to be going directly toward the fox, and reaches him when he runs 60 rods north, or in other words, a tangent to the curve at each point must intersect the fox's course at the moment the fox crosses said point of intersection. The following diagram will show this clearly.

When the dog is at D the fox is at F;
When the dog is at D′ the fox is at F′,

the point where tangent at D′ intersects the line F E; also when the dog is at D″ the fox is at F″, the point where the tangent to the curve at D″ intersects F E, and the same for all points on the curve. At E the curve becomes tangent to the line F E, and therefore E is the point where the fox is overtaken. To solve the problem it only remains to find the length of the arc D E of the ellipse such that its length shall be 5-4 times the semi-transverse axis *a*. We have from the theory of the rectification of curves the following Equation in case of an ellipse:

s—the length of the curve, equals

$$\int d\,x \frac{(a^2 - e^2 x^2)^{1/2}}{(a^2 - x^2)^{1/2}}$$

Solving or integrating this between the limits x—o and x—a we have approximately, as the developement cannot be made exact.

a—nearly 86 rods,
and s—5-4 a—107 nearly.

This we think is the correct answer to the problem, or at least as far as we have carried out the development of the above equation.

Yours truly, M. T., Jr., C. E.

PESHTIGO, Wis., August 1, 1875.

EDITOR NEWS:—Will some readers of the NEWS please answer the following questions in your next issue?

the Azimuth, or true bearing, with the Right Ascension

1st. Given the Latitude of the observer's place, and Declination of the Sun, or a star, to find the Local Time, when the Altitude of the observed body is unknown.

2. Given the Latitude of the place, the Right Ascension and Declination of the Sun, or a star, and the apparent local time, to find the Azimuth or true bearing of the observed body—the Sun or star.

Respectfully, AMATEUR.

HARTFORD, Conn., Aug. 9, 1875.

EDITOR OF NEWS.

Dear Sir:—The answers to the two first questions in Practical Mathematics, published in your last issue, are as follows:

1st. The Dog will run 139.2 rods before catching the Fox, and will travel in an elliptical path.

2nd. The size of the square will be 20 x 20 feet.

Yours truly, W. A. T.

To Correspondents.

D. D. C., Olympia, Wash. Terr.: Sent chain by Express. H. W. S, Toronto, Ont.: We hope you have received your copy of "Hints to Young Engineers." G. W. O., Sioux City, Iowa: We sent you 3 yds. continuous profile paper, plate A, by mail, on the 11th. W. P. H., San Francisco, Cal.: Humber's Record of Modern Engineering, for 1865 and 1866, 2 vols., were sent per Am. Express. on the 12th. The second vol. of Baldwin Latham's Sanitary Engineering is not yet out, but I will advise you at once when it is. J. D. S. Evansville. Ind.: I hope you have received all the books ordered. They had to be sent from three different houses. R. G. E., New Tacoma, Wash. Terr.: The first edition of Vose's "Manual for Railroad Engineers, &c.," has been sold out; a second is now in the bindery of the publishing house, and your copy will be forwarded as soon as it can be had. J. B., Lancaster, Wis.: There is no published Record Book for the use of county surveyors. There are several methods for getting up such a book proposed, and when the times improve no doubt some one of our enterprising surveyors will publish a Record Book. In the mean time if a sufficient number of plans and full explanations were sent to this office, so that a fair comparison could be made, we might assist in getting out a suitable book. J. D., Port Dalziel, Ont.: "Concrete," by Henry Reid, was sent to you by mail.

Weight of Water.

According to Act of Parliament 5 Geo. IV., c. 74, a cubic inch of pure water at 62° F. weights 252.458, from which we calculate that its weight at 60° F. should be 252.5, or 4 cubic inches=1010 grains; the weight, therefore, of a cubic foot is 62.33 lbs. The weight of a cubic foot is generally assumed by engineers as 62½ lbs.. or 1000 ounces. The following table of approximate values will be useful in all practical calculations founded on English measures of weight and capacity:—

1 cubic foot of	water	=1000 oz.
1 cubic foot	"	=62½ lbs.
16 cubic feet	"	=1000 lbs.
36 cubic feet	"	=1 ton.
1 cubic yard	"	=¾ ton.
1 cubic fathom	"	=6 tons.

When the weight is required in tons, reduce the linear dimensions to fathoms, and multiply the volume by 6.

For calculating water pressure in pounds per square inch, we must find the weight of a prism of water one foot high, standing on a square inch.

$$\text{Weight} = \frac{1010 \times 12}{4 \times 7000} = \frac{3.03}{7}$$

Therefore we have the follow rule:—

For every 7 feet of depth allow 3 lbs. pressure per square inch. To the result add one per cent.

For calculating water pressure on circular areas, we must find the weight of a cylinder of water one foot high and one inch in diameter.

$$\text{Weight} = \frac{11}{14} \times \frac{1010}{4} \times \frac{12}{7000} = \frac{34}{100}$$

Therefore we have the rule:—

For every 400 feet of depth allow 34 lbs. pressure per square inch of diameter squared.

For sea water, which has a greater density, add to the results of all such calculations 2½ *per cent.*, or one-fortieth part.

WEIGHT OF AIR.—With the barometer at 30 inches, and the thermometer at 60° Fahr., the weight of 100 cub. inches of air equals 31 grains, or 814½ less than the same volume of water. At the earth's level every flat surface sustains a pressure at right angles to it, which is equal to the weight of a column of the atmosphere, whose section is equal to that of the surface, and whose height is equal to the total height of the atmosphere, and it has been shown by experiment that the weight of a column of the atmosphere is equal to the weight of a column of water 34 *feet* high, or of mercury about from 28 to 31 *inches*, according to the height above sea level, either column standing on a base of the same area as that of the atmospheric column. From these experiments it is shown that the pressure of the atmosphere corresponding to the barometric column of 30 inches, is equal to 15 lbs. per square inch, and therefore the elastic force of a gas or vapour is estimated at so many atmospheres or any given number of times 15 lbs. of pressure per square inch.

On the Work Done by Agents or Machines Moving Uniformly.

When a body is in a state of uniform motion, it appears from Newton's First Law of Motion, that the forces acting upon it are in equilibrium; but any attempt to stop the body, at once developes the force residing in it. When a living agent or a machine is doing work, in a state of uniform motion, the work applied must be equal to the work of resistance, for, since the motion is uniform, the forces acting must be in equilibrium with the resisting forces. We shall consider several cases of this kind of work, which is of constant occurrence in practice.

1. WORK DONE BY FORCE.—The *work done* by a force is expressed by the weight *lifted* through a given height by the force, and is therefore the product of a weight by a height—

Work done=weight x height.

This equation is evidently true, because the work is proportional to the weight raised, and also to the height to which it is raised; if either of these be changed in the same ratio, and it is therefore proportional to the product of the weight and height to which it is raised.

Let *W* denote the work done, *P* the weight raised, and *h* the height to which it is raised, by the action of a force; then

$$W = Ph. \qquad (3)$$

In this equation *P* is expressed frequently in pounds avoirdupois, and *h* in feet; the unit of work to which *W* is referred is sometimes called the "foot-pound," to signify one pound lifted through one foot.

If *w* denote the work done in one minute by an agent, such as a man, horse, &c., working in a particular manner, *t* the number of minutes the agent is employed, and *n* the number of agents at work, it is evident that the work done in the time *t* is

$$W = wnt. \qquad (4)$$

Tables have been constructed, founded on experiment, showing the quantity of work per minute which various agents are capable of accomplishing: from these Tables the value of *w* is known for each agent; and by their aid many useful questions in practical mechanics may be solved.

If we wish to compare together the work done by different agents, we make use of the following equation:—

$$wnt = w'n't', \qquad (5)$$

in which the accented letters refer to one set of agents, and the letters without accents to the other.

The following Table is calculated from the results of Navier, Morin and other writers. There is a great diversity in the total amount of the diurnal work assigned to the various kinds of labour: the larger results for human labor are certainly erroneous, and are opposed to our own observations.

WORK DONE BY VARIOUS AGENTS,

MAN.	Duration of Labour	Work per Minute.	Work per Day.
	hours	ft. lbs.	ft. tons
Raising his own weight on a ladder	8	4222	905
Raising weights, with a cord and pulley,	6	1559	250
Raising weights, with the hand,	6	1472	236
Raising weights on the back, on a ladder,	6	1126	181
Raising weights on a slope, with wheelbarrow,	10	519	139
Shovelling materials to a height of 5 ft.,	10	467	125
Working inside a treadmill—			
a. On a level with the axis,	8	3897	835
b. Near the bottom of the wheel (24°),	8	3637	779
Pushing or drawing horizontally,	8	3117	668
Pushing or drawing alternately, vertically,	10	2380	637
Working a windlass,	8	2598	557
Working with the arms and legs, as in rowing,	8	4000	857
ANIMALS.			
Horse yoked to a wagon, walking	10	27279	7307
Horse yoked to a carriage, trotting	4.5	41914	5052
Horse yoked to a whim, walking,	8	17356	3719
Horse yoked to a whim, trotting,	4.5	25980	3131
Ox yoked to a whim, walking,	8	15588	3340
Mule yoked to a whim,	8	11691	2505
Ass yoked to a whim,	8	4849	1039
Steam-horse of Watt and English writers,	8	33000	7071
Steam-horse of French writers,	8	32475	6959

In equation (3) the work done is expressed absolutely as the product of a weight and a height; in equation (4) it is expressed in terms of a number of agents of a given description, acting for a certain time; equating these two values of *W*, we find

$$Ph = wnt. \qquad (6)$$

In this equation there are five quantities:—

P—the *weight* lifted.

h—the *height* through which it is lifted,
w—the *work* done by an agent per minute,
n—the *number* of agents,
t—the time during which the agents work;

any four of which being given, the fifth may be found.

The following are a few of the numerous important practical questions which may be solved by equations (5) and (6):—

EXAMPLES.

What should be the horse-power of a steam-engine capable of raising 750 tons of coal per day of 12 hours from a pit 100 fathoms deep?

Since the agent here employed is the steam-horse, we have—

P=750 x 2240 lbs.,
h=6 x 100 ft.
w=33000 ft. lbs.
n=required horse-power
t=60 x 12 min.

Ans. 42.4 H. P.

An engine of 20 horse-power is employed to pump water to a height of 60 ft. to supply a town of 5000 houses with water, at the rate of 80 gallons per house; how long must the engine work each day?

Here we have, since the gallon of water is 10 lbs.,

P=5000 x 80 x 10 lbs.
h=60 ft.
w=33000 ft. lbs.
n=20.
t=required time in minutes.

Ans. t=6h. 4m.

A party of 500 shovellers is employed to throw up an entrenchment in soft ground, and works for 10 hours per day; how many cubic yards of earth will be thrown up in 10 days, supposing each cubic yard to weigh two tons?

P=required weight.
h=5 ft.
w=467 ft. lbs.
n=500.
t=6000 m.

Ans.—61,544 cub. yds.

If 30 men be employed on a building 30 feet high to carry bricks to the masons; how many bricks will they raise in 7 hours, allowing 17 bricks to 125 lbs.?

P=required weight of bricks.
h=30 ft.
w=1126 ft. lbs.
n=30.
t=420 m.

Ans. 64,317.

Density of the Earth.

The density or specific gravity of the Earth has been found by a variety of methods. The earliest and simplest of these methods is that used by Maskeleyne, Hutton, and Playfair, in the years 1774, 1775, and 1776.

A mountain called Schiehallien, in Perthshire, was relected for the purpose, partly on account of its segular shape, and partly because it was composed in nearly equal parts of granular quartz, mica schist, and crystalline limestone, the specific gravities of which were easily ascertained, and pretty constant. The cubical contents of this mountain were carefully ascertained by Mr. Hutton, an operation which required an accurate survey of the mountain, and laborious calculations; and from the cubical contents of the mountain and its shape, it was possible to calculate its attraction cm and $c'm'$ upon plumb-lines oc and $o'c'$ placed at opposite sides.

The result of this laborious calculation was given by Mr Hutton in the following manner:—If we suppose the Earth to be composed of the same materials as the mountain, and that oc or $o'c'$ represent the attraction of the Earth upon the plumb-line, *i.e.*, its weight; then the Earth's attraction will be to the sum of the opposite attractions of the mountain in the proportion of the figures 87522720 to 8811 2-3 or as 9933 to 1 very nearly.

If, therefore, E denote the attraction of the Earth

upon the hypothesis that it has the same density as Schiehallien; and M denote the sum of the opposite attractions mc and $m'c'$ of the mountain, we shall have

$$E=9953\times M.$$ (Hutton's equation.)

Two astronomical observatories were then placed upon the north and south sides of Schiehallien, the observations in which were made by the Rev. Nevil Maskelyne, Astronomer Royal, upon the following principle:—

If the mountain Schiehallien exerted no influence whatever upon the plumb-lines co and $c'o'$, they would each point to the true zenith of the place of observation Z and Z'; instead of pointing to Z and Z', they were observed to indicate two points z z' further away from the mountain; and by measuring the angles Zoz and $Z'o'z'$, the ratio of the true attraction of the Earth, to the attraction of Schiehallien may be found as follows:—In the triangles moc and $m'o'c'$ the lines mc, $m'c'$ represent the attraction of Schiehallien, and $oc=o'c'$ the attraction of the Earth. Hence we have

$$mc=co\times\tan moc.$$
$$m'c'=c'o'\times\tan m'o'c'.$$

The sum of the angles moc and $m'o'c'$ was found to be 11"·6; and since the angles are small, we may substitute for each of the tangents the value of the angle in seconds divided by the number of seconds in an arc equal to radius. We thence obtain the proportion, that the attraction of the Earth is to the sum of the attractions of Schiehallien, as

$$206265'' : 11''\cdot6, \text{ or } 17781 : 1.$$

If, therefore, the Earth be n times as dense as the mountain Schiehallien, we find

$$n\,E=17781\times M.$$ (Maskelyne's equation.)

Combining the result with that found by Hutton, we obtain for n, which expresses the density of the Earth referred to Schiehallien as unity—

$$n=1.79009.$$

It now remained to obtain the specific gravity of Schiehallien, which was accomplished by Mr. Playfair, who found the rocks composing the mountain to vary from 2.4 to 3.0 and 3.2. Mr. Playfair considered the mean density of the entire mountain to lie between the limits 2.7 and 2.8, most probably close to the latter; assuming 2.8 as the specific gravity of Schiehallen, we find for the specific gravity of the Earth

$$2.8\times n=5\cdot012.$$

The value just found for the density of the Earth should undergo some small corrections for the diminution of gravity caused by the rotation of the Earth, but it is not worth while to introduce them, since they are much smaller than the probable errors caused by an inaccurate estimate of the density of Schiehallien. Nearly all the methods proposed for determinining the density of the Earth are open to this objection, that they require an accurate knowledge of the mean density of large masses of rocks.

But there is one method, invented by Cavendish, which cannot be here described, by which the attraction of the Earth is compared with the attraction of a sphere of lead of known size and density; in this case we know accurately the density of the object compared with the Earth; but on the other hand, the attraction of the sphere of lead is very small compared with that of a mountain such as Schiehallien or Mont Cenis, used in Carlini and Biot's experiments.

The following values of the mean density of the Earth are those found by the best observers:—

Density of Earth.	Observer	Method Employed.
5·012	Maskelyne, Hutton and Playfair.	Deviation of Plumb Line caused by Schiehallien.
4·837	Corlini and Biot.	Pendulum experiments at Bordeaux and Mont Cenis
5·480	Cavendish.	Torsion Balance and Pendulum.
5.440	Reich.	" " "
5·670	Baily.	" " "
5.480	Airy.	Pendulum experiments in Aarton Coalpit.

From these various results, we find the mean density of the Earth is not very different from 5500 times the density of water.

The Weight of Rails and the Breaking of Iron Rails.

BY O. CHANUTE, C. E.

Paper read before the American Society of Civil Engineers.

THE WEIGHT OF RAILS.—The writer has long entertained the opinion that the assumption of any fixed relation between the weight of a rail and the maximum load borne by one pair of wheels passing over it, was misleading and fallacious. A simple consideration of the pressure on the surfaces in contact between the driving wheels of the locomotives and the rails will make this apparent. If the wheel and the rail were both inelastic, the contact would be a line, and the pressure would be infinite. Being elastic, however, they both yield a little, and the contact becomes a surface.

Ten years ago the writer took some pains in measuring these surfaces, and then found them to average about ¾ of an inch across the face of the rail, and about ⅜ of an inch along its length; giving an area of 9-32 of a square inch, on which a weight of 9,000 pounds will exert a pressure of 32,000 pounds per square inch—10,000 pounds, a pressure of 35,555 pounds per square inch, and 11,000 pounds, a pressure of 39,111 pounds per square inch. These experiments have recently been repeated upon the Erie Railway. Those which seemed most satisfactory were made by jacking up simultaneously both wheels of a pair of a pair of drivers, and introducing between them and the rails a sheet of thin tissue paper. By lowering the wheels upon the paper, and allowing their full weight to rest thereon, a very good impression of the surface was obtained.

In the following Table the pressures are *statio*, and as ordinary wrought iron begins to crush at about 38,000 to 40,000 pounds to the square inch, the weights noted, when put into motion are pretty sure to smash down any material so soft as ordinary bar iron. While the maximum weight on the wheels, therefore, should undoubtedly govern the hardness of the *material* in the head of the rail, it

has no relation to the *weight* of the rail, except so far as this results from its necessary form and proportion as a girder to carry and distribute the weight to the supports, and this again is modified by the distance there may be spaced apart.

No. of engine	Diameter of driver. ft.	in.	Weight on driver. Pounds.	Position of wheel.	Condition of wheel.	General size of impression. Inches.	Area in contact. Inches.	Pressure per square inch Pounds.
338	5	0	11,175	Right.	Worn.	7-16×¼	0.13	85,961
"	5	0	11,175	Left.	Much worn.	2×3-16	0.42	26,607
482	4	7¼	11,358	Right.	Newly turned.	¾×⅜	0.32	35,494
"	4	7¼	11,358	Left.	Newly turned.	7-16×⅜	0.14	81,128
492*	5	0	11,912	Right.	Partly worn.	¾×7-16	0.36	33,089
"	5	0	11,912	Left.	Partly worn.	¾×⅜	0.35	34,084
384	5	0	11,185	Right.	Partly worn.	¾×⅜	0.32	34,952

If these premises are correct, it follows that the adding of weight to an iron rail, already sufficiently stiff to carry the load, would only ensure its more rapid destruction, by making it too rigid to yield slightly under the wheel, and perhaps by preventing such slight deflections between the supports, as is found admissible in practice, and which by curving the rail to some assimilation with the wheel, probably increases slightly the areas in contact, and so diminishes the intensity of the crushing pressures. Hence we find that in many cases, some light shallow rails, with hard material in the head, thoroughly welded, have greatly outworn much heavier iron rails, under the same traffic.

Hence, also, railroads with a heavy traffic, requiring powerful locomotives, 11,000 to 12,000 pounds per wheel, in order to haul maximum trains and keep down the expenses of their train service, really cannot afford to lay any but steel rails in their main tracks. Railroads with a moderate traffic, which cannot as yet afford to buy steel rails, and have from 10,000 to 11,000 pounds on their engine wheels, should stipulate for the hardest iron it is possible to place in the heads of their rails, with a due regard to perfect welding; while those with a light business would actually find it more profitable to sell any locomotives with more than 10,000 pounds per wheel, than to have them crush and destroy the iron rails now laid in their tracks, before the growth of the country furnishes a remunerative business.

It is therefore suggested, as of more pressing importance to many of our American railroads, that they should presently proportion their machinery to the rails now laying upon them, than to endeavor to adapt the rails to the machinery. In the building of new roads, the weight and character of the rails have been governed by financial rather than truly economical considerations. Railway Presidents and directors have consulted the treasurer rather than the engineer. The latter should therefore endeavor now, so to have the engines proportioned as not to exert crushing strains on the rails.

As the first set of rails become worn out, and the trafic increases, the weight of the locomotive is sure to increase, and it is right that it should do so. Rates will be decreasing at the same time that the volume of business increases, and the expenses of train service will be assuming a larger proportion of the total cost of operating, so that it will be desirable to economise, and to diminish the proportion of cost of train labor, by increasing the size of the trains. This result is inevitable, and when this second period arrives, it would be a mistake to oppose an increase in the weight of locomotives to conform with moderate practice, which then becomes both necessary and economical.

When this occurs, however, the weight upon the driving wheels should govern the *material* in the rail, rather than its *weight*, and endeavors should be directed to the selection of the best materials and proportions for the second set of rails, whether of steel or of iron, instead of looking to a mere increase of weight, which as herein before stated, may become a positive detriment, The weight of the rail will result from its form and depth, and it should be designed as a girder or beam resting upon several supports, so as best to carry and distribute the loads on the wheels. The distance apart of the ties or supports, will be governed by their cost, by the depth assumed for the rail, by convenience in tamping and repairs, as well as by the character of the soil, of the machinery and of the traffic. It may be stated in general terms, that the best practice in this country seems to point to the laying of rails 4 to 4½ inches deep, weighing from 56 to 68 pounds per yard, upon ties spaced 2 feet from centre to centre.

The following rules are therefore proposed as a substitute for that fixing the weight of rails as a multiple of the maximum weight upon a driving wheel.

1st. Rails are to be designed as girders resting upon several supports, on the same principle, and from the same general data as those now applied to bridges.

2d. Where locomotive driving wheels are loaded to 11,000 pounds or over, the rails should be of steel.

3d. When from any cause it is not possible to provide steel rails for such weights, the material in the heads of iron rails, should be the hardest it is possible to weld thoroughly to the body of the rail.

THE BREAKING OF IRON RAILS.—Sufficient attention has probably not been given to the age of iron rails, or rather to the amount of traffic which has passed over them as affecting their liability to fracture in cold weather.

Some years ago, the writer was in charge of the maintenance of way on a prominent Western railroad. About 71 miles of this had been laid in 1854, with an English rail of about 58 pounds weight per yard. It was pear headed, and laid with wrought-iron chairs upon joint ties. During the winter of 1864–5, these rails which had hitherto proved amply strong for the traffic and machinery, began to break under the trains, and some 300 of them snapped upon this division during the continuance of the cold weather. This breaking ceased when spring returned, and during the ensuing summer and autumn, few or no breakages occurred.

The condition of the track, already much improved, compared with what it had been in former years, was still made better during the working season. About 15 miles were relaid with re-rolled iron, thus reducing the amount of old rails upon this portion of the road to about 56 miles; many new ties were put in, and great attention paid to the surfacing, draining and ballasting. Notwithstanding this, as soon as cold weather set in, during the winter of 1865–6, the rails began to break under the trains at a most alarming rate. Sometimes from 50 to 100 rails would be reported broken of a night, and about 3,400 rails snapped upon this 56 miles during the continuance of the cold weather. As most of these rails were 18 feet long, this amounted to about 5¾ miles of track, or over 10 per cent. of the whole.

Immediate measures were taken to guard the safety of the trains. Passenger trains were slowed to a speed of 20 miles per hour, and freight trains to 12 miles per hour, over this dangerous portion of the line. It was divided into patrols from three-fourths to one mile in length, and watchman were put on night and day, to walk over the track after each train, to look out for broken rails, while the section gangs were held in readiness at all times to repair or replace any breakages. These mainly occurred over the shoulder

*The experiment on engine 492 was made by substituting thin bank-note paper for the tissue paper, and that on engine 384 by wetting the rail around the area in contact with the wheel with a solution of sulphate of copper. The copper being deposited on the rail and wheel, left a bright spot of iron untouched where the surfaces had been in contact. Neither of the latter experiments were deemed as satisfactory as those with tissue paper.

ties, or those next to the joints, and about 20 to 24 inches from the end of the rail, although sometimes the rail broke into three or four pieces under the train. The precautions taken proved so effectual that after they were adopted, only 22 trains went off the track (of which but one was a passenger train) on this portion of the road, and in every case the trains were thrown off by rails which broke under them.

The process seemed as follows: the rails broke under the engine, but this almost invariably passed over in safety, the car wheels then successively loosened the broken pieces of rail, until one of them threw it out of line, when the next wheel would go off the track, and the train would be wrecked, generally towards its rear end. In the vast majority of instances (say 3,400 to 22) the broken pieces of rails were not thrown out of the track by the train which had broken them, or if so, only dropped out of line after the last car had passed, and were soon thereafter found by the watchman, when a new rail would be put in, or the pieces secured in place, so that the next train, which was flagged, could proceed in safety.

Most of the breakages occurred when the weather moderated after a very cold snap. A comparatively mild night, after two or three days of intense cold, always showed a large increased number of broken rails in the daily reports of the watchmen. An increase was also shown when the weather turned from mild to cold, the predisposing cause seeming to be a change in the temperature, and consequently in the internal strains of the rails. As spring and warmth returned, the rails gradually ceased to break. It is almost needless to say, that during the succeding season, the whole of that 56 miles of track was relaid with new rails.

Incredible as this experiment may seem, it is believed not to be singular. It is within the personal knowledge of the writer, that an engine without a train, with a flat driving-wheel broke no less than 163 rails, upon another Western railroad in running 30 miles, without getting off the track herself, and that some lines have recently had an experience very similar to that above described, as to the numbers of breakages.

It seems certain that after rails have been run over, either a certain number of times or of years, they become much more brittle, and likely to break off square without warning. They may have proved to be sufficiently strong during the first few years after which they were laid, and then suddenly develop increased brittleness, and break in large numbers under the same class of rolling stock, and the same conditions of working as those which they have successfully withstood during previous winters. This has been partially counteracted on some lines by annealing repaired rails. For this purpose they have been roasted to a dull red heat, over fires made of old ties, and allowed gradually to cool, but the results have not been sufficiently satisfactory to warrant a continuance of the practice.

The reader will naturally conclude that these experiences tend to confirm the theories of so called granulation or crystallization of iron under severe strains. That a very great reduction of its tensile strength takes place under repeated and severe vibrations is abundantly proved, but an inspection of the fractures of these rails did not lead to the belief that any process at all analagous to crystallization had taken place. A minute examination of the foot of the broken rails rather conveyed the impression of bright broken threads, while the heads presented a more granular appearance. If we consider that in the operation of rolling, the original grains of the wrought-iron were gradually lengthened into fibres, and that repeated tensions and vibrations would tend to break and separate some of these fibres, especially when a change of temperature had altered the internal strains in the rails, we will probably form very nearly an idea of what really took place. The fact that the greatest number broke when the weather moderated, and the general position of the fracture over the first tie, back from the joint, led to the belief that they probably first broke by tension in the head. The latter having greater mass than either the foot or stem, would absorb heat and expand more slowly, and therefore would be in greater initial tension, especially in the night when the counteracting of the sun's rays would not be present. A rail being substantially a continuous beam resting upon a number of supports, would, on the passage of a load, have its top strained in compression between the point of contrary flexure between the ties and in tension over the supports. Hence the breaking over the shoulder ties upon a slight yielding of the joint.

If this theory be correct, it follows that not only must care be exercised in obtaining a hard quality of material for the head of iron rails, in order to resist crushing, that this material must weld perfectly to the plates beneath it to avoid lamination, but also that it must be strong iron and sufficiently worked to develop tensible strength, in order that the rail shall not become brittle in using. Curiously enough, the rails which have proved most liable to fracture within the experience of the writer have been of comparatively heavy section, and generally pear-headed. The most brittle he has ever known were a lot weighing 72 pounds per yard, originally laid upon the Portage Railroad of Pennsylvania and transferred to a Western line.

The re-rolled rails made from those taken up on the 56 miles which have been alluded to, never broke. They had a very great surplus of strength, but they proved so soft that they were crushed to pieces in 3 or 4 years, while the original stock from which they were made had lasted from 10 to 11 years in the same track.

Topographical Surveying and Keeping Survey Notes.

BY RICHARD P. ROTHWELL, C.E., M.E.

A paper read before the American Institute of Mining Engineers at Hazleton, October, 1874.

The communication which I have to lay before my fellow members of the Institute, is no elaborate paper, or the statement of any great discovery; it is simply the record of convenient methods of conducting topographical surveys, and of keeping the notes of the same; methods that have grown out of practical experience, and have saved me many a day's labor by facilitating office and field work, and at the same time secure a greater degree of accuracy than is obtained by the methods now in general use.

I assume it as granted that no topographical map is worthy of the name, except it represent the elevations and depressions of the surface by means of horizontal or contour lines.

In the ordnance survey of great Britain the contour lines are traced for every fifty feet vertical height, I believe, by running out the line with level and compass through all its meanderings on the surface; this, of course, is a very tedious, though accurate process, but "in the woods," where many of our surveys have to be made, it would be practically impossible.

Sometime ago, I made an extensive and quite elaborate topographical survey and contour map of the southern portion of the Cahaba coal field in Alabama, the object of the survey being to determine the best route for a railroad to enter the coal field, and open that portion of it where the quality of the coal and the size of the beds made it desirable to open mines. The country is greatly broken by ridges and valleys running in every direction, so that it is exceedingly difficult to select the *best line* in all respects, for while it is easy enough to find the best place to cross any one ridge, it is by no means easy to find the line that, though perhaps not the best in crossing any one obstruction, will yet give the best mean results. This could only be done by having a complete contour map of the district, such a map being also essential to the intelligent selection of the best point at which to open mines.

As many of the engineers present know, the financial limits set to such work are, in this country, and especially in the south, very restricted. We have to combine speed and economy with accuracy in such work.

The State of Alabama has its lands divided into Townships, Ranges, and Sections, by lines runnnig north and south and east and west. I made these section lines, one mile apart, the main lines of my survey, and ran them in some cases with the transit, reading both deflections and needle back and fore sights, and in other cases simply with the surveyor's compass. In the total absence of any magnetic attraction I prefer the com pass. My distances were most carefully measured, either with a brazed link steel chain or with a steel tape, and a stake was driven every hundred feet. These stakes were at least eighteen inches high (so as to be easily found in the brushwood), and were marked as in railroad work, the distance on one side, and at all desirable points with the elevation above tidewater on the other side. Thus X. 87+50 marked on the front of the stake, and 735.62 on the opposite side being X. line station, 8,750 feet from the starting point, and the elevation of the surface at this point is 735.62 feet above the sea. The levelling is done carefully, and checked by cross lines. These section lines are approximately North and South and East and West, though not quite straight nor uniform in their variation, owing to errors in the original survey.

This survey is tabled by latitudes and departures, and can thus be plotted on ordinary cross section paper, without the use of protractors. The lines on the paper being taken as magnetic meridians and east and west lines.

The notes of section lines are kept in the manner prescribed by law. The level man as he runs over them, if thought desirable, sketches in the contour of the surface for a few hundred feet on each side of his line; this, however, is not necessary, as the work is done in a subsequent operation.

We now assume some convenient corner as zero, or starting point, plot in the section lines on the cross-section paper, by latitudes and departures, taking the lines on the paper as magnetic meridians and east and west lines. Those passing through the starting point are the zero meridian and zero east and west line. If we make our map, and the note books, on a scale of 500 feet to the inch (a very convenient scale in extensive surveys), every tenth line (heavy lines) on the paper will be marked as we recede from the zero lines, thus: 5 E., to E., 15 E.; 5 W., 10 W., 15 W., etc.; 5 S., 10 S., etc.; so that any point in the district may be designated by a name which indicates, without a moment's consideration, exactly where it comes on the map; thus 65 E., 15 N., is a point 6500 feet to the east and 1500 feet to the north of the zero point of the survey.

To get the topography, I run lines 500 feet apart, either north and south or east and west, but not in both directions over the same ground. These lines commence at some station on the section lines, and are run due north and south or east and west, on the 500 feet lines. They are run with the pocket compass and steel tape or chain and with the Locke pocket level. These lines close on the section lines, and a check is thus given to the work at intervals of one mile; as the section lines are staked every 100 feet, and the elevation marked on the stakes, the check is perfect and immediately applied, for when commencing the line the man in charge knows exactly when he should intersect the next section line. If he does not strike this point, he can at once verify his work.

With careful work, the variation in direction of the line run a mile with the pocket compass will never exceed 10 feet, and will generally be within 5 feet, either of which is as close as we can plat on the scale used. The level runs over these compass lines with the pocket or Locke level will seldom vary 5 feet in running a mile over rough ground, errors balancing; and as they check up on the section lines every mile, this error can be reduced to say 2½ ft. midway between the section lines.

The notes of the survey are kept in a note-book made of X section paper ruled the same on both sides.

We write from bottom up. Thus we will write at foot of page:

"*Running line* 17 *N.*"—We see at once the line being run is an east and west line at 1700 feet north of the zero E. and W. line, we commence at, say, "35 E." on this line—that is, at a point 3500 feet east and 1700 feet north of the zero or initial station of the survey. We know, without looking to another line, exactly where our starting point is on the map, and can, without a moment's hesitation, point it out.

After running 500 feet, we find the station is 40 *E.*, so that the line is being run *east;* the topography is sketched on as the work proceeds, the field-book in scale and fullness being a finished map, the final map being merely the transfer on to a single sheet, in a better style, of the several pages of the note-book.

The surveying party consists usually of but five persons, three of whom may be green boys.

1st. Axe-man, who is also a flag-man.
2nd. Compass-man.
3rd. Front chain-man.
4th. Level-man, who is also rear chain-man.
5th. Rod-man.

If the timber is thick, it may require a second axe-man to be able to clear the line as fast as the level-man can get his notes and sketch in the topography.

The advantages of this manner of conducting a survey are speed, economy and *accuracy*, for no error can extend beyond a mile, and the notes are all made and map *finished on the ground*, with every feature before the eyes of the draftsman, so that if his work be not correct, he knows it at once before leaving the field, and can seek and find the error with but little loss of time.

At night, and during wet days, the work is all "posted up" on sheets of cross-section paper, so that the entire map is complete before leaving the camp, and, in fact, each days's work is complete in itself; and if the survey be suddenly interrupted, as was that to which I referred to above, none of it is lost, but it can at any future time be taken up just where it was left off without any difficulty. The notes do not need the presence of the man who made them to interpret them, as is not unfrequently the case, and tell where his line comes on the map; for each page tells itself exactly where it belongs, and as it is itself the complete original of the map containing every contour and feature of the surface, as sketched and figured on the spot, it leaves nothing to the artist's imagination.

The rate at which a party, such as above enumerated, will run out and level these secondary lines depends on the nature of the country. In broken ground, where the brushwood is not to thick, from 7,000 to 15,000 feet of line per day can be run, putting in contour lines every 10 feet vertical, and sketch ing for about 300 feet on each side of the line. If the lines are run 500 feet apart, this allows an overlap of 50 feet, which serves as a check in bringing the work together on the sheets. The thousand little practical details that facilitate the work, and which suggest themselves naturally to the engineer in the field, are not here mentioned; it is sufficient to call attention to the gen eral outline of the method, and to say that its practical usefulness has been fully proved, for it has been the outgrowth of an extensive experience.—*Eng. and Mining Journal.*

Consolidation of Earthworks.

BY JULES GAUDARD, CIVIL ENGINEER, LAUSANNE.

Translated from the French by James Dredge, C. E.

[CONTINUED.]

* The conditions involved in the formation of efficient drainage and protection of works and of cuttings will now be considered; passing on next to the question of repairs necessary after the occurence of a landslip, and then a few words will be added on the consolidation of embankments. The principal sources whence this information has been drawn are:—Nouveau Portefeuille de l'Ingenieur des Chemin de Fer, par Pardonnet et Polonceau, p. 128; and from the Documents, Rapport de de M. Bruere, p. 103, also p. 153. Traite de l'entretien et de l'exploitation des Chemins de Fer, par Ch. Goshler, 1st volume, Traite pratique de l'entretien des tranchees et remblais. Minutes of Proceedings of the Institution of Civil Engineers, 1844 and 1845.

Cuttings.

The side slopes of a cutting may be drained by the construction of channels (Sazilly system) if the water bearing seams are clearly defined; by pipe drainage if the distribution of water is more vague and general; and, lastly, by filtration in the case of water-bearing sand.

1. In water-bearing strata.—In some instances a deep, narrow trench has been excavated in the bank, at a sufficient distance from the face of the slope, the sides of the trench being timbered and filled with dry stone (Fig. 12). The planes of moisture in the prism ABC dry up, and the earth gradually and surely becomes consolidated. This method is good; but costly; it may be employed to arrest movement already commenced. It is generally sufficient to fill only a part of the trench with stones, which may then be coverered with moss, straw, or turf, and the filling-in may be finished with rammed earth.

Sazilly devised a more economical system of small longitudinal drains, established near the face of the slope, and formed in the vicinity of the seam. At the bottom of the cutting in the face of the slope (Fig. 13), is placed a channel, formed transversely of three tiles set in hydraulic mortar. The tiles employed for this purpose are 3·15 inches wide, and and ·788 inch thick; or the channel can be more easily formed with a single row of ordinary half-round tiles. Round or broken flints, 2 inches or 2½ inches in diameter, or sometimes furnace slag, are thrown over the channel. The larger pieces are placed below, and the smaller nearest to the water-bearing seams This stone filling, heaped against the vertical side of the cutting, in the face of the slope, is always high enough to cover any irregularity in the line of the water discharge. The surface may be covered with turf, or with a layer of clay or matting, with tiles, or with flat stones, to keep ont the mud which would gradually choke the drain. Two lines of water discharge, at least 18 inches apart, can be served by the same channel. This system of drainage is laid in the face of the slope, with gradients, of at least 1 in 100, and at their successive lowest points they discharge into the side drains of the railway. The cost ought not to exceed one shilling per lineal yard.

It is necesssry to protect the whole of a slope of loamy soil with a covering against the action of the rain, sun and frost. The revetment may be executed in earth, in successive layers from 6 inches to 8 inches thick, laid with a slope opposed to the face of the bank. Vegetable earth is suitable, or clayey sand, or a mixture of clayey marl and vegetable earth. A certain proportion of friable clay has even been added without inconvenience, as, for instance, on the Hundsoff and Strohubel cuttings on the Wissembourg line. Ramming renders the bed almost impermeable; nevertheless M. Bruere recommends the formation of a small drain at the foot of the slope, to carry off such of the surface water as may have penetrated through the revetment. Finally, the surface is sown or planted with couch grass, clover, lucerne or French grass; occasionally with shrubs, acacia, willow, birch maple, &c., the deep roots of which spread, compressing and consolidating the ground. Care must be taken at all times to prevent the roots from choking the drainage channels.

Sometimes trenches or furrows are formed in the face of the slope to give the protective covering a better hold (Fig. 14); but this is not necessary when the inclination of the slope is small. The base is frequently finished by a stone revetment. Revetments of rammed earth are better and less costly than stonework, which permits the infiltration of water. Ordinary turfing would be insufficient, whilst turfs laid as in Fig. 15 would be costly, and still permit water to enter between the interstices.

In deep cuttings, and especially in those which are commanded by a higher natural slope, it is of great importance to check the action of the surface water in its descent, in order to prevent the scouring of the sides. With this object a ditch is often formed at the foot of the natural slope (Fig. 16), as, for example, in the Morcert and Guerard cuttings on the line from Paris to Coulommiers. This ditch must be of clay, puddled to make it impermeable; it collects and carries off the water coming from the higher levels. This method is open to the objection that it disturbs the integrity of the surface, and thus affords facilities for the percolation of water, which may affect the stability of the work. An open channel in stone or brick is better (Fig. 17); but there is still a more preferable mode. This consists in dividing the face of the slope into a number of stages, in such a manner that the dangerous action of surface water is greatly reduced. Each of these benches prevents the water from acquiring velocity as it descends the surface, and retains it at each bench on account of a reverse inclination of 15 per cent. being given (Fig. 18). Lastly, it conducts the water by the longitudinal face towards drains laid at intervals on the surface of the slope. These slope drains are sometimes, for the sake of economy, turfed as in Fig. 15, or planked, or formed with tiles. But when they are placed so far apart as to receive large quantities of water, it is advisable to construct them in masonry set in hydraulic mortar, with joints faced in cement. Thus formed they should cost about 3*s.* 5*d.* the lineal yard if 39 inches wide. The side ditches themselves ought to be protected with stonework, especially at the bottom, and towards the main slopes; or, at least, they should be flat turfed.

As to the banquettes, which receive only a small quantity of water, and the slopes of which are moderate, they are simply covered with properly-rammed earth, or are flat turfed, the joints being made good with vegetable mould. The revetment of a slope, including banquettes, drains, ramming, &c., ought to cost from about 5¾*d.* to 8¾*d.* per yard, or perhaps 9·3*d.* per yard, including the extra excavation, which is afterwards made good by the covering of rammed earth.

The width of the benches may be varied a little, in order that the general profile of the cutting may approximate to the curved form which a natural slope would assume (Fig. 19).

The channels, up the side of the cutting, which take off the water from the trench drains, may be either open in masonry, or, better (Fig. 20), formed of small stones, covered by the revetment, and resting on the natural ground. It will be convenient to make a banquette immediately over the head of the sloping drain, to give facility for examining and maintaining the latter.

Pipe Drainage.

When the water-bearing seams are numerous, irregular, or indistinct, pipe drains may be employed, wherever any discharge of water shows itself. These form narrower channels than the Sazilly drains already described, and this feature renders them inefficient to draw off the water from well-defined seams. But when these latter are more scattered, the earth has sufficient permeability to allow the whole of the moisture to percolate to the drains, provided only that these are placed close enough together. The drains are laid at the bottom of narrow trenches. It is advisable to pack the

*From the Proceedings of the Inst. of Civil Engineers, 187 4

joints with moss or reeds to prevent them from being stopped up too easily; and sometimes they are protected by sand and small stones, covered with moss, straw. or turf, and the trench is finally filled with rammed earth.

In England, especially on the Croydon and Birmingham railways, the efficiency of these drains has been increased by making numerous small openings in them enlarged towards the inside (Fig. 21). Owing the form of the holes, any mud which may enter from the outside of the drain frees itselt immediately and passes off with the water. The joints are formed with sockets. A line of drain pipes (Fig. 22) is placed along the crest of the slope, and from this others descend transversely into the side ditch. At regular intervals a vertical pipe, C, rises from the main line, for the purpose of ventilation. The circulation of air thus obtained causes the deposit left in the pipe, in dry weather, to crack, and thus it is easily removed the first time water passes through the pipe: but, on the other hand, this arrangement encourages a choking vegetable growth within the drain. The pipes are laid 5 or 6 feet below the surface, towards the foot of the slope, and three feet beneath at the top. They are spaced about 15 ft. apart.

On the railway from Blemes to Gray, M. Ledru laid 1·18-inch drain pipe in the slope, 39 inches below the surface (Fig. 23), and at intervals of from 10 to 20 feet, according to the moisture; these discharged into longitudinal collectors, placed near the side ditches. A third central collector drained the roadway, and was placed in connection with the two lateral drains by pipes laid from 32 to 65 feet apart. They are formed of pipes 3·34 inches diameter, and are covered with broken stones.

When the upper part of the bank only requires draining, it is sufficient to lay down a longitudinal line of pipes or tubes discharging into the open air.

M. Daigremont employed on the Eastern railway of France, a system copied from Germany, or perhaps rather from England, because it is almost identical with that described by Captain Moorsom. Drains at least 2·36 inches diameter, surrounded by a filtering material, and with a minimum inclination of 1 in 200, are laid in a deep, narrow trench M N, to the rear of the top of the slope D C, Fig. 24. On that side of the trench farthest from the face of the slope are placed small vertical pipes about 6 feet 6 inches apart, and 1·45 inch in diameter. These pipes are stopped short of the surface of the ground, and are closed at the top with plugs of reeds, while they communicate below with the longitudinal drain. The trench is then filled with earth and well rammed. Other collectors beneath the side ditches drain the formation to a depth of about 4 feet. The mass M N E C D being thoroughly drained by this means, acts as a counterfort to resist the thrust of the moist ground behind M N, and the slope D C may even be made with an angle of 45°. It is urged against this system that the trench MN would encourage the disintegration of the earth, and that in bad ground the deep, narrow trenches would be costly in execution, especially where timber was necessary. M. Daigremont describes applications of this method of longitudinal trenches in the cuttings of Petit-Croix, Dannemarie, &c., and he adds data concerning their cost. In the Donkemberg cutting, transverse galleries have been driven to drain the slopes.

Here may be mentioned the Ashley cutting on the Great Western railway, which was drained by a system of inclined transverse galleries and of sumps, connected by a longitudinal gallery in such a manner as to tap all the water-bearing seams. On the Great Eastern railway (Brentwood Hill cutting), the slopes were drained by sumps filled with broken stones, and by discharge drains. On the Lyons railway, M. Jullien also sank shafts to the water-bearing deposit, and affected the drainage by discharge pipes.

A cutting in the North of Spain, on the line crossing the Pyrenees, was attended by landslips, although the stratifications (marl, clay, schist, sand) were normal to the face of the upper slope. In such a case the water is retained in pockets, and can only be removed by a syphon. Collecting wells were sunk, and surrounding trenches were made, as well as a system of galleries.

On the Western railway of Switzerland, M. Lelanne laid rows of drain pipes in the slope, Fig. 25, in such a way as to dry a considerable thickness of earth. A number of pipes are joined together with sleeves, as shown in Fig. 26, *m m'*. These joint-sleeves are kept at their proper distance apart by means of an iron wire which connects them together. The length of pipes is then introduced into the hole formed in the face of the cutting by a boring tool. The method is not applicable in cases where the earth has been much disturbed. Care must be taken that the orifices of the pipes, which project slightly from the face of the slope, do not become choked with mud, or frozen, and the slope ought to be well turfed under the points of discharge. Perforated pipes would be preferable to the ordinary plain ones, which are so easily obstructed.

In the retaining wall at Euston (London and North-Western railway), holes were made to admit 3-inch drain pipes of cast iron, to a distance of 4 feet. The wall was thus relieved of a thrust which threatened its destruction. When in course of erection, the rear face of such a wall may be provided with a kind of grating, discharging through perforated pipes.

M. Goschler gives, in his "Traite des Chemins de Fer" (vol. i., p. 56), examples of draining the road bed of a railway, by means of masonry channels, or by drains.

In conclusion, the mode of draining by means of clay pipes appears to be that chiefly used, and most favorably thought of. Thanks to the play permitted by the joints, the pipes can accommodate themselves to slight settlements, which would of necessity dislocate the Sazilly drain. Besides they can be laid at a considerable depth with but little excavation, and they answer their purpose well, when the body of water to be carried off is not so excessive as to require the construction of more important works. They are generally of small diameter, and are laid in parallel rows, following the face of the slope, discharging into longitudinal collectors of larger size, placed either at the sides or in the centre of the road bed. For these longitudinal drains the fall ought not to be less than 200.

As examples showing the importance of the cost of drainage, the following are borrowed from M. Couche:—

At Vincourt (Blainville-Epinal line) for 2,990 square yards of slope, there are 630 feet of secondary drains, and more than 920 feet of collectors. At Sourbourg (Strasbourg-Wissembourg) 1,200 square yards of slope are drained by 920 feet of secondary drains, and 1,800 feet of collectors. The average cost per lineal foot of the drain, laid complete, may be taken at 7*d*. Lastly, 2-inch drain-pipes, sunk to a depth of 3 feet below the rails in the Maranvillier cutting, cost about 9*d*. per lineal foot.

FILTERS.

In water-bearing sands, which discharge from their whole mass, drainage can only be partially successful, and it is necessary to have recourse to filtering appliances, covering the whole of the slope which is to be consolidated. On the Northern railway of France a stone facing, from 4¾ inches to 6 inches thick, covered with stone packing, or turf, 11¾ inches thick, is adopted. A 9-inch or 10-inch revetment is sufficient to keep out the frost which would stop the water discharge. When there is an abundant flow of water, the filters should be of considerable thickness, and the best mode is then to adopt 'gravel fascines' (Fig. 27). They are formed of envelopes of brushwood, fastened by fascine bands, osier, or iron wire, and well filled with gravel or broken stone, These fascines are laid in horizontal furrows formed in the face of the slope (Fig. 28). It is a somewhat delicate work, and must be executed rapidly, commencing from the top of the bank, so as to avoid the inconvenience of the water passing off. A layer of gravel about 4 inches thick is put on to equalise the surface, then a protective cover of flat turfing, and finally 6 inches

of vegetable earth. M. Bruere has, amongst other similar works, drained the Schantz cutting on the Wissembourg line.

Sometimes. in very fluent sands, the side ditches of the road bed fill in as fast as they are made. The most efficient remedy against this is to place first two fascines, as shown in Fig. 29, and to excavate the intermediate material. At the end of a few days the upper bed will be drained, and two other fascines may be laid at a lower level, and so on; finally the ditch is lined with stone (Fig. 30).

Specifications for Street Pavement, Chicago, Ills.

CURB-STONE.

The curb-stone to be set on....Street to be of the best quality of Athens stone, or stone equally as good, free from cracks, seams and sand mixture, to be not less than four feet (4) long....deep, and....inches thick, when dressed, with top edge full and square, free from drill holes and other defects, and having close joints, full width, at least one half the depth. Each stone to have a straight base the whole length, and be firmly bedded upon flat stones. In no case shall wood be used for such purpose. Each stone must be neatly bush-hammered as above. The corner or catch-basin stones at the corner of the streets must be cut to a true circle of four feet (4) radius, must be bush-hammered eighteen inches (18') down from the top surface. The top must also be neatly bush-hammered, and free from drill-holes or other defects.

The inlets to the catch basins must be four inches (4') deep, fourteen inches (14') wide, cut from the bottom of the stone to within nine inches (9') of the top.

When necessary, and required by the Board of Public Works, said curbing shall have back filling solidly rammed down, sloping from a point six inches below the top, two feet to one. Return curb will be set at all intersections of streets and alleys on a line of said streets, to be of same quality as above specified, and no extra charge will be allowed for circular or catch-basin stones. All curb-stones now set on said street that are not in line or grade, must be placed in proper position, and no lines or grades will be given for the setting of curb-stones until the same shall be dressed according to specifications.

.....

FILLINGS.

The fillings shall be of sand, clay, earth or gravel, and free from any animal or vegetable matter, or any perishable material. It shall be compactly put in, and well puddled, rammed and rolled with a roller of not less than five tons weight, and be so firm and compact as to be secure from settling. The filling or grading shall be brought to within....inches of the top of the pavement, and shall be smoothly graded, and shaped to conform to the shape of the pavement, so that the ballasting, gravel or sand on which the wooden paving shall rest, will be of a uniform thickness.

Approaches connecting said....street with other streets or alleys where not improved, will also be filled, so that the same shall have a slope not greater than one foot in twenty.

The contractor will not be allowed to remove the earth from the sidewalks with out the consent, in writing, of the Board, and when required, the contractor shall fill back of the walls or curbstone to the original level.

All sidewalks on line of said street that must necessarily be removed in order to build walls or set curb-stones, must be taken up by the contractor and carefully preserved. The owners in every case must be notified of such removal.

.....

GRADE.

The top of the wooden blocks at the corner of the curb-stones (at the catch-basins), at the intersection of said... with other streets to be....inches below the grade of the sidewalk, and crown an arch from the gutter to the centre of said.... street....inches; thence rising to a point of intersection of the centres of....street with other streets four inches (4'), so that the centre of said intersection shall be four inches higher than the other four centres at the streets lines.

The contractor will be required to have one block graded in advance of the paving, so that the engineer in charge of the work may not be unnecessarily detained on said work, and in no case will stakes be given for the paving until the grading is perfectly done, as above named; nor will extra charges be allowed for detention, on account of putting in water or gas pipes or sewer drains, or raising catch-basins or man-hole covers.

The gutters shall rise from the corners of the aforesaid curbs towards the centre of the block at the rate of six inches in one hundred feet to a summit, as shown on the aforesaid drawings.

PAVING.

The wooden block pavement shall consist of:

FIRST. A bed of lake shore sand four inches (4') in thickness, laid upon the top of the filling and smoothly rounded to the shape of the street, as per sections in the office of the Board of Public works, in the book of street improvements, page.. making a part of these specifications. The ballast, sand, etc., to be clean, uniform in character, containing no pebbles of a larger diameter than one inch.

SECONDLY. Rows of sound, live 4x8 inch Norway or white pine blocks. free from sap, loose or rotten knots or other defects, twelve inches (12') long, placed on end upon the sand, the rows running diagonally across the street, and being kept an inch apart. The blocks in the different rows of the pavement to break joints in a similar manner as in brick masonry.

The blocks shall be fitted so as to make close joints, and shall be uniformly laid, not varying in thickness more than a quarter of an inch in the same row. All rot, sap, and other defects to be trimmed off.

The spaces or joints between the rows of blocks shall be filled with clean, bank paving gravel, and compactly tamped down by means of a paver's tamping iron, prepared to fit the joints, so that all parts of the same shall be thoroughly rammed. The whole surface shall then be covered with roofing gravel, or gravel screened from that used to fill the spaces between the blocks; said covering to be put on not less than 1½ inches thick, and rolled with a roller of not less than five tons weight, if required.

CROSS-WALKS AND APRONS.

There will be four cross-walks at each street intersection, and one at the centre of each block, unless otherwise directed by the Board of Public Works. Said cross-walk to be eleven (11) feet wide, and so constructed that the centre of the walk will be level, and three inches below the grade of the sidewalk.

All aprons at the street crossings to be made of two inch pine lumber. These aprons will not be less than eight feet in width, made in such a manner as to be easily removed for cleaning underneath. Must be put together with two battens of 2x6 inch lumber, and strongly nailed together with 30d nails.

The culvert plank will be 3x16 inch pine, and not less than fourteen feet in length, and put down in best manner. Three 3x6 inch posts must be driven next the curb for the aprons to rest upon—all to be made by the contractor without extra charge.

All labor and material connecting the new pavements with the openings for sewerage, gas, or water purposes (such sewerage and water structures to be brought by the city to grade, and gas structures by the Gas Company), and in general every thing necessary to fully complete the work, so that with the completion of the paving, the street shall be in complete order, ready for use, shall be furnished and done by the contractor.

MISCELLANEOUS.

Any thing omitted, and shown on the aforesaid drawings, and vice versa, shall be done by the contractor without extra charge or cost to the City of Chicago.

The contractor will be required to remove, at his own expense, all obstructions that may be in the way of making said improvement.

To put up and maintain red lights, at night, at all holes or other dangerous places on said street, and to keep all such

dangerous places on said street at all times sufficiently barricaded and protected, to guard against accidents of any kind.

All walls and curbing, and all filling, must be fully completed before the paving is commenced, unless otherwise ordered by the Board of Public Works, or their Superintendent.

If the collections already made for said improvement shall, from any cause, be insufficient to pay the costs thereof, the contractor is then to wait for collections from assessments, to be hereafter made by the City of Chicago.

During the progress of the filling of said ..... street, and the erection of the curb-walls, and the curb-stones thereon, said contractors will be required to keep free and unobstructed any street or other railway along the line of said improvement, keeping all stones, carts, materials and all obstructions of whatever sort away from the track of such railway, so that cars may be run along the same, and said railway be used in its customary manner, without hindrance; and said contractors will be held liable for all damage resulting from any failure to comply with this stipulation.

No drain pipes laid in said street shall be disturbed in any way, and square holes 12x12 inches, shall be left around them where they pass through any wall to be built, and if they come below such wall, and within six inches of the bottom of it, an opening of 12 inches in width and six inches high must be left over them to relieve them from the pressure of the wall.

The contractor will be held responsible for any damage done to the drain pipes, in addition to the penalty prescribed by the ordinance.

Societies of Rural Art and Rural Tastes

It is twenty-two years since a lady of Western Massachusetts founded the first Village Improvement Association in America. Perhaps she brought back the suggestion from Heidelberg, where such care is lavished on the preservation of the famous castle and the adornment of streets and grounds that a thousand foreigners are charmed into a permanent residence in that beautiful German city. Perhaps that sense of the unloveliness of our average rural life which everywhere oppresses cultivated persons moved her to attempt a reform.

Her method was a simple one. By personal solicitation and eloquence she inspired her neighbors with a sympathetic desire for beautiful surroundings. Presently a working organization was established under the name of the Laurel Hill Association, whose office was to beautify the town. Its fee of membership was small; its duties were not burdensome. Once a year it made a holiday, and celebrated itself most modestly in the romantic woodland from which it took its name.

When it had completed its majority it looked back on twenty-one years of such good works as ought to be both inspiration and example to all country folk. Streets had been widened, graded, and lined with trees. The hap-hazard gutters, with their fringe of ragged turf, the ugly throats of the little bridges which so disfigure country roads, had been reformed altogether. In place of staring bridge guards, painted white, were vine-wreathed rustic railings or fanciful iron balustrades. Around some huge old wayside tree a rustic staircase climbed to a quaint balcony among the boughs, where the wayfarer might rest. The neglected "green" was translated into a verdant park. The forlorn New England grave-yard had become a shaded, blossoming, grassy cemetery, full of bird-song and fragrance and rest.

All this was public work, but it inspired a private enthusiasm which doubled its success. Every garden and door-yard in the town disclosed aspirations towards the beautiful, fulfilled or struggled after in turf and flowers. If a house was to be repainted, it seemed to put off with its painful white-lead and Paris green, the old bare life of unchanging labor, and to put on, with its modest livery of cool browns or grays, the new life of æsthetic impulse and occasional leisure of books and croquet. In short, the whole tone of the village life was pitched in a nobler key.

Besides these gains, a missionary spirit had spread abroad the knowledge of this gospel of rural beauty. In other villages of Massachusetts, in many towns of Connecticut, in New York, and in far-away Wisconsin, shoots from the parent tree have taken root and flourished. These societies are made up of men and women of all degrees of wealth and culture, whose bond of union is a desire for rural embellishment. Membership is obtained by paying a fee of one dollar, or by planting a certain number of way-side trees. Perhaps a monthly meeting is held at the houses of the members in alphabetical order, where, after a simple supper, some topic of rural art, previously assigned, undergoes thorough discussion. The result is seen not only in the growing loveliness of the hamlet, but in a more genial and cultivated social life.

The value of beauty cannot always be reckoned in day-book and ledger. In these instances its presence or absence is a simple matter of profit and loss. Real estate has steadily and greatly advanced in all the towns which cherish a society of rural art. Wealth and culture have been attracted to them from without. Their hotels have been crowded with summer boarders. Every citizen is the richer for this enlisting of the gracious agencies of nature to work while he sleeps.

But an immaterial wealth has been added to the community which no figures represent. The educational value of this æsthetic spirit can hardly be overestimated. Character is largely due to its surroundings. The well-ordered home, where beauty and culture are a perpetual presence, develops children into refined men and women. Sensuality, coarseness, the vulgar satisfactions of the world, do not fascinate them, because they measure enjoyment by intellectual and artistic standards. The æsthetic village does for its citizens what the æsthetic home does for its inmates. It makes the conduct of daily life a constant education. It calls on its very highways and hedges to teach that love of neatness, order, harmony, and beauty which leads to the highest civilization.

From the country the city constantly recruits its wasting mental and moral force. The qualities which the young rustic takes to the pavements are the qualities which are shaping our national life. Through trade, politics, the professions, journalism, their image and superscription are every where imprinted. Our young men and women, therefore ought to desire the life of towns above that of the country, chiefly because they there attain a broader culture and wider usefulness to their kind, command larger industries and more beneficial outlays of intellectual power.

As it is, they long for the cities because these seem to offer them that share in the graces and amenities of existence, in its brilliancy and fullness, their need of which the average village existence steadily ignores. They seek to escape from the bondage of the country to the freedom of the town, and their uncultured incapacity often finds that freedom a bitter slavery.

This eagerness to crowd into cities, to live always in the public eye, is an unhopeful tendency. But scolding will not remedy it. The town is desired because it seems desirable. When we make the country lovable, we may be sure that it will be loved. This is the mission of these societies of rural taste and art. The beauty which they cherish for its own sake brings wealth. That wealth brings culture. That culture demands the satisfaction of books and music. And the village library and village concert-room have, in more than one instance, grown out of an experiment in way-side tree-planting.

This whole work of rural embellishment must be begun, at least, by women. There is hardly a village in the land where two or three earnest and persevering souls might not awaken the spirit and intelligence of reform. The great lack of our national culture is the absence of the æsthetic sense. Without it we may live honestly, but we can not live highly. Those of us who are rich enough in wisdom and money, go to Europe for the education of its galleries, its sculpture, its monuments, its architecture. Glories like these we can not hope to see upon Amer-

ican soil. They have grown out of conditions, and have been fostered by influences, alien to the spirit of our institutions. The gracious daily life of a vast people must be the expression of our national art. And they are the best citizens who soonest set their faces toward this high calling.—*Harper's Bazar.*

Notes on Iron.

A flanged tyre bar, 5 in. x 1.8 in. and containing 10.2 square inches, requires upwards of 200 tons pressure on a pair of ordinary shears to cut it open. In one experiment 210.6 tons were required.

A new railway bar has been known to break in three pieces on simply falling from a wagon.

A cast iron pillar, loaded with 97-100ths of its calculated ultimate breaking strain, bore the load six months and then broke.

Locomotive tyres are gradually extended in circumference by the friction to which they are subjected. They often become so loose upon the wheels as to require to be taken off and set anew.

Steel swells in hardening. Iron absorbs carbon and swells in case-hardening, as well as in conversion into steel. Forgings of scrap iron are liable in case-hardening to absorb carbon unequally, and to twist or warp, owing to the irregularities of the iron.

In punching long angle-iron with closely pitched holes, as for rivetting, the iron is stretched, often ½ inch in 10 feet, and a different template should be used in laying off the hole in such iron, so as to allow for the stretching.

Cast steel when hardened to too great an extent, has been known to explode violently. A case was reported in the Franklin Institute Journal for 1844, where a hardened steel step or bushing, 1¾ inches in diameter, and having a ⅛ inch hole, exploded with a report like a pistol.

A steel wire or bar of steel of whatever diameter, having a tensile strength equal to 150,000 pounds per square inch, would just support its own weight, if 8 3-5 miles (46,166 feet,) long, and suspended freely from one end.

Forgings which have been hammered when nearly cold often prove very brittle, a quality occasionally attributed to crystallization. Such forgings, however, if brought to a good heat and allowed to cool slowly, recover their natural toughness.

Hard cast iron, when cast in very large masses, and allowed to cool very slowly, is found to become soft. Heavy guns, when cast solid from hard iron, are found to bore easily.

The strength of 1¼ inch bolts, made of a given quality of iron, being 23 tons per square inch, Mr. Brunel found the strength of 1 inch bolts of the same iron to be 25 tons per square inch, whil ¾ inch and ⅝ inch bolts of the same iron bore respectively 27 and 32 tons per square inch.

By successively reheating and reworking puddle iron, Mr. William Clay found that while its original tensile strength was 43,904 pounds per square inch, its strength at the sixth reheating was 61,824 pounds. Subsequent workings reduced the strength until at the twelfth reheating it again stood at 43,904 pounds.

Iron is injured by punching. Mr. Fairbairn has found that iron, of which the average strength was 52,486 pounds per square inch, was so far injured by punching, that the metal left between the holes bore but 41,590 pounds per square inch. This loss of strength is in addition to the actual loss of material punched out.

Corrugation has been found to afford such strength to plate iron that a single sheet, so thin as to be unable to bear its own vertical position, bore 700 pounds after corrugation, without bending.

Although steel is believed to be harder and stronger in some proportion to the amount of contained carbon, cast iron, when it is very rich in carbon, is soft like plumbago, will break by its own weight, and may be cut with a knife.

Native iron has been discovered in but very few parts of the world. Specimens have been found in Australia, and in Canaan, U. S., there exists a seam of native iron two inches in thickness, from which horse-nails have been forged.

In casting long hollow columns, great care is requisite to keep the core exactly in the centre of the mold. One of the iron pillars of the Pemberton mill, which fell at Lawrence, Mass., in December, 1859, was found, after the fall of that structure, to be only 1-16th inch thick upon one side.

A bar of cast iron of one square inch of section, in the form of an equilateral triangle, and on supports 32 inches apart, supported 1437 pounds with one angle uppermost, and 860 pounds with the angle downwards.

The Franklin Institute, of America, found, many years ago, that boiler plates possessed their maximum strength at a temperature of 550°. Mr. Fairbairn found the strength of iron plates to be unaffected from 0° to 600°, and that from 600° to a red heat the iron lost about one-fourth of its strength.

Wrought iron railway wheels are hardly ever used in the United States. The wheels generally used are of cast iron, 33 inches in diameter, weigh about 520 pounds, and are chilled on the tread or wearing surface by being cast in an iron mold.

Shafts of cast iron may be mended, when broken, by pouring on melted iron to form the part required, the pouring being continued with a surplus of metal until the new parts are fused upon the old.

Mr. E. A. Cowper has tested no. 22 music wire to a strength of 102 tons per square inch.

Solid columns of a height exceeding 25 diameters will fail in almost every case, by bending. Hollow columns do not fail by bending until the height is as much as 50 diameters.

An alloy of 100 copper to 16 of tin is said by M. Dussoussy to furnish tools which, hardened and sharpened in the manner of the ancients, afford an edge nearly equal to that of steel. This, however, is very doubtful.

The fluidity of the Berlin iron from which the finest and sharpest, although not strongest, castings are made, is attributed to the presence of arsenic in the iron.

In turning Krupp's cast steel tyres the lathe requires to be driven at about one-half the speed at which ordinary tyres are turned.

Steel containing 1¾ per cent of carbon will not weld, and iron containing more than 2 per cent of that element is not malleable.

Mr. Hobbs has welded large bars of puddle steel at a heat lower than that required to weld iron.

From Professor Barlow's experiments on beams it appeared that the strength of the skin of bars of British cast iron was about 2½ times greater than that of the interior.

A two inch square bar of the best and most fibrous Lowmoor iron, has been completely crystallized by being hammered by two men for half an hour.

Crane-chains, originally made of strong fibrous iron often become crystallized after two or three years of constant use. Their fibrous condition may be restored by heating and gradual cooling.

How to make Fine Lawns and Roads.

CHICAGO, Aug. 30, 1875.

TO THE EDITOR OF THE ENGINEERING NEWS:

DEAR SIR:—In answer to your request for information as to the mode adopted on the Chicago South Parks, of procuring good turf for the lawns, planting spaces, &c., and also of building the roads through the Parks, I have much pleasure in stating, first, with regard to the grass, that the soil is prepared by ploughing during the summer, or if on the ridges (which, as you are probably aware are nothing but sand), by covering them with at least a foot of good vegetable soil, which we procure from the low grounds adjacent; in the following spring this is well harrowed until the surface becomes perfectly even, and at the same time well dressed with rotten manure, and on some parts of the Park it has also been treated with a dressing of clay; it is then sown with a mixture of blue grass, red-top, and white clover, about three and one-half bushels to the acre, and rolled. As soon as it has come up sufficiently for a lawn mower to cut it, it is mown and rolled again; and on those parts of the Park where it is desired to have a really fine lawn, this mowing and rolling is repeated all through the growing season, at the rate of two or three times a month. This treatment has been quite successful, and the second season we have a lawn that will compare with any. Of course the preparation of the ground must vary according to the nature of the soil you have to deal with, and in the case of such light soil as ours it would no doubt be advantageous always to give a good dressing of clay, as it assists very much in retaining the moisture, though our grass suffered very little from drought, even last summer, which was a very trying one in that respect. The chief essentials then for producing a fine velvety lawn seem to be a sufficient depth of soil to enable the grass to withstand a dry season; a plentiful supply of seed and constant mowing and rolling.

The roads in the Parks, where only light vehicles are allowed, are made in alternate layers of clay and lake shore gravel. The sub-grade is prepared with the same crown as the road should have when finished, and on this as first spread about two inches of clay, on that a layer of coarse clean gravel, which is then rolled with a heavy roller, so as to embed the gravel in the clay; a layer of two inches of clay is then spread upon that, and on the clay, about an inch of finer gravel; the whole is then well rolled. If there is too much clay, so that the road sticky on the surface after rain, a little more gravel is added until the surface becomes clean and hard; these roads are better than either a gravel or macadamized road with the material we have here, being much less dusty, much more easily kept in repair, and costing about half what the others do.

Yours respectfully, HENRY J. SAMS,
Engineer in Charge, South Park Commission.